POWER

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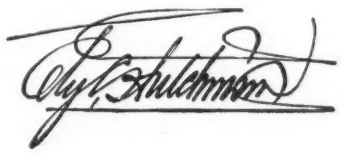
Old Man Economics

It looks as though "Old Man Economics" were settled well into the saddle and ready for a long ride. On all sides is evidence that alert attention to dollar conservation is replacing intellectual lassitude, and this is nowhere more true than in the power field.

No matter where one goes the story is the same. A diesel plant is installed in combination with a steam turbine because the figures proved it a money maker. A utility is exhaustively studying diesels as adjuncts to a hydraulic power system because of the resultant lowering of distribution cost. Utilities, because of the pressure for lower rates, are looking to plans for locating plants closer to centers of load or remodeling strategically located installations previously thought to be outgrown.

Power plants for industry are taking on an added vitality, largely as the result of recent concentration upon their economic and technical requirements by highly competent engineers. The same holds true for power and heating plants in buildings. Even where central steam service is available an economic opportunity is being utilized by running the steam through engines instead of reducing valves, thus converting the inherent energy to useful purpose.

These days, the savings effected by resourceful thinking may make the margin that means success.



EDITORIALS

No Smoke Department In Cleveland

As a result of the recent switchabout in Cleveland, sixteen years of city management government is now superseded by the election of a Democratic mayor. Whether this is because of a complete change of political thought in the city is not so important, for the purpose of this discussion, as the fact that coincident with the election of the new Democratic mayor, a streak of economy has, for the time being anyway, swept the Smoke Department into the discard.

As an aphorism, with which to perpetrate some of the most illogical governmental economies, probably none has been so widely misused as "balance the budget." There is no quarrel with the principle, but the method of its application has, in many cases, produced strange results.

Fortunately, it is not likely that the large plants, utility, industrial, or otherwise, which are the potential smoke producers in the Cleveland district, will take advantage of the absence of a Smoke Department by immediately reverting to the old-time conditions they have done such good work to correct. There still remain, however, numerous small producers the aggregate of whom may be depended upon to make a great deal of soot and dirt.

It does not take much imagination to realize that the cost of conducting the Smoke Department can easily be exceeded many times over by the damage to health and property resulting from an unbridled community of smoke producers. Politically, however, this may not be so important as budget economy and the lopping off of a department, while the saving is paid many times by the taxpayers in increased laundry bills, clothes, bills, paint jobs, and the like. Certainly government at times "moves in a mysterious way, its wonders to perform."

One wonders at times whether the people, or the politicians, will ever come to realize how backhanded some of their decisions really are.

Factory Owner Defeats Own Ends

A factory owner was recently advised by a salesman that he could save money by generating his own power. As the plant already had a boiler which supplied both low- and high-pressure saturated steam for process, the salesman said, it would only be necessary to install a turbine which would exhaust low-pressure steam for factory use and generate most of the power required. Being an engineer, although without previous power-plant design experience, the owner decided to make the installation himself, without the help of a consulting engineer.

After considerable delay due to lack of equipment that had been overlooked, the turbine was finally put into operation. It was soon discovered that the boilers did not have sufficient capacity to deliver to the turbine the steam required to generate all of the power demanded by the factory. To overcome this condition the old stokers were removed and replaced by oil burners with the expectation that the boilers could be forced to higher outputs. Inadequate furnace volume for the type of burner employed made it impossible to carry more than about 100 to 125 per cent rating. Consequently additional changes were necessary.

Had a consulting engineer, experienced in power-plant design, been employed he could have saved, in installation cost alone, considerably more than his fee. A more efficient installation would have resulted, and the factory owner would have had more time to devote to factory problems. Thus a good opportunity for economy was mistreated for no reason but penny wisdom and pound foolishness.

Decibels for Power Engineers

"Decibel" is the latest addition to the power engineer's private vocabulary, and another example of the merry chase science is leading him.

This sort of thing has been going on for years. In the now dim past, power plants operated without conscious benefit of physics, chemistry, thermodynamics or electronics. In those days coal burned to smoke and ashes; water boiled into steam. Steel was steel and brass was brass and life was simple for any man who had a reasonable mount of practical experience.

But academic notions crashed the gate, first one by one and then in bunches. Coal was found to contain B.t.u. as well as dirt. Steam was discovered consorting with entropy, heat of vaporization and adiabatic expansion. Metals developed crystalline structures, fatigue and creep limits.

And the power engineer must now make room for the newfangled "decibel." This measure of sound intensity is almost as hard to explain as the quantum theory, but its uses are clear and practical, as will be seen in the leading article of this issue. The day is not far off, it appears, when the bidder on certain types of power units must meet a standard of "quiet" as definite and capable of measurement as the standards of capacity and efficiency.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

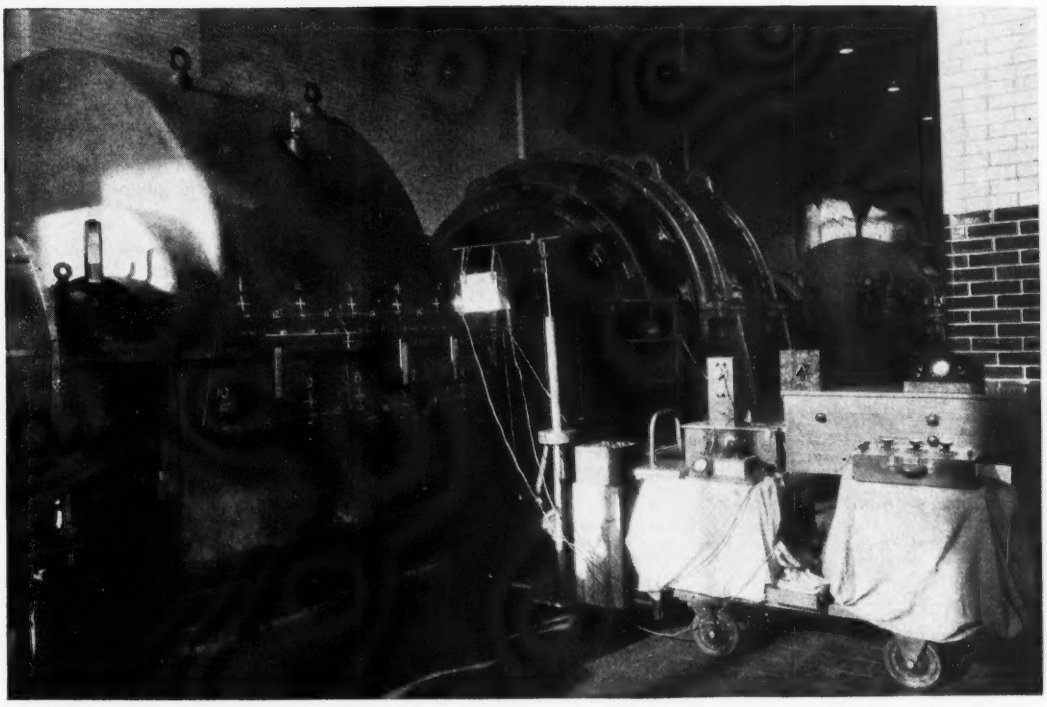


Fig. 1—Noise analyzing and measuring equipment set up for analysis of double herring-bone reduction gear

Specifications of POWER NOISES

By E. J. ABBOTT
Research Physicist
Engineering Research Department
University of Michigan

A - B - C

MUSICAL NOTE — Sound of a single frequency, whether found alone or accompanied by other sounds.

UNPITCHED SOUND — That part of a sound which has no particular pitch.

TOTAL NOISE — Sum of all unpitched sound and musical notes found at a given place and time.

ACOUSTIC PRESSURE — The variation in the atmospheric pressure which constitutes the sound. A convenient unit of acoustic pressure is the bar — 1 dyne per sq.cm. The voltage produced in a soundmeter for a given note is ordinarily proportional to the acoustic pressure at the microphone. Sound energy is proportional to the square of the pressure.

DECIBEL — The practical range of acoustic pressures is so large that data are usually most conveniently interpreted in logarithmic units. The decibel is defined by the formula

$$Decibels = 20 \log_{10} \frac{Actual\ pressure}{Reference\ pressure}$$

The reference pressure is usually arbitrarily chosen as the smallest pressure of the given sound which the average human ear can detect. On the average, 1 db. represents about the smallest change in loudness which the human ear can detect.

AS PART of the specifications for the reduction unit of a geared turbine-generator in a large central station it was decided to include noise limits. These noise limits were determined on the basis of a series of physical measurements of the sounds produced by a group of similiar gear units in actual operation.

The type of unit under consideration is shown in Fig. 1. It is of the double herringbone type, and is driven by a pair of steam turbines which operate at 3,000 and 4,000 r.p.m., respectively. Each of these is direct-connected to a pinion, both pinions meshing with a common bull gear. This gear is direct-connected to a 360-r.p.m., 240-volt, 4,000-kw., direct-current generator. Eight identical units of this type were available in the plants of the Detroit Edison Company, for which company the work was conducted and with whose permission this material is presented.

Program of Measurements

Two sorts of sound measurements were made on each machine, "total noise" and "frequency analyses." For the so-called "total noise" measurements, all of the component notes of the sound were measured simultaneously.

The soundmeter consisted of a condenser transmitter, a vacuum tube amplifier and an indicator meter. The over-all frequency-response of the instrument was adjusted to conform with the experimentally determined "80-decibel equal-loudness contour"[1] for sounds of ap-

[1] "The Loudness of Pure Tones," by B. A. Kingsbury, *Physical Review*, April, 1927, page 588.

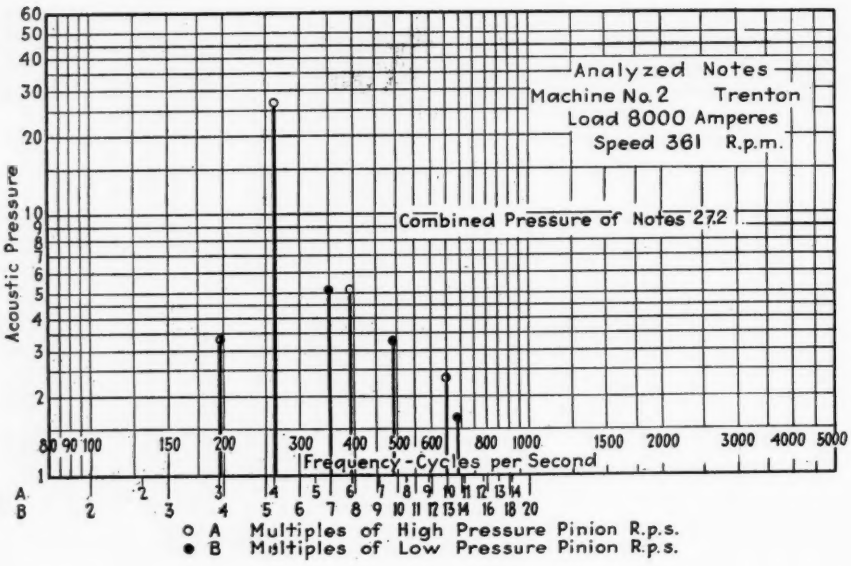

Analyzed Notes
Machine No. 2 Trenton
Load 8000 Amperes
Speed 361 R.p.m.
Combined Pressure of Notes 27.2
Acoustic Pressure
Frequency - Cycles per Second
A Multiples of High Pressure Pinion R.p.s.
B Multiples of Low Pressure Pinion R.p.s.

Fig. 2 — Analyzed notes for machine 2. Acoustic pressures are measured in "bars." Note that sound frequencies practically coincide with integral multiples of pinion speeds

proximately the observed loudness level. The data were recorded in terms of decibels above the threshold of hearing for the 1,000-cycle note which gave the same meter reading.[2] Experiments indicate that these values give a fairly close approximation to the loudness as it appears to the average observer.

Frequency analyses were made by means of a special frequency-analyzer circuit provided in the soundmeter. With this circuit, the response of the amplifier was confined to sound of a single frequency, and this frequency could be adjusted much as a radio is tuned. It was soon found that a large part of the sound from the gears consisted of a group of musical notes. By varying the tuning of the analyzer over the audio range, the amplitude and frequency of each of the musical notes was measured separately. The analyzer was sufficiently selective to separate out and measure individually any note which could be heard by ear.

The sound varied considerably from point to point on each machine. These variations were larger than the difference between the quietest and the loudest machines, and the locations of the loud and quiet spots were different for each machine. For this reason it was impossible to obtain proper comparative readings by measuring at corresponding positions on the various machines.

Such variations are nearly always encountered in machinery noise measurements, and are attributed to interference between the various vibrational waves in the machine and in the air. In this case it appeared that these effects could be fairly well eliminated by averaging the readings obtained at the ten stations indicated by chalk marks visible on the gear case in Fig. 1.

During the measurements the microphone was placed six inches from the gear case, but even this close to the machine an appreciable part of the total noise came from sources other than the machine which it was desired to measure.

To correct for this effect, a second series of measurements was made on each machine with that particular machine at rest and the remainder of the station running as it had been when the original measurements were made. The machine noise was then computed by subtracting the sound energy of the room noise from the sound energy of combined gear and room noise. In most cases this correction was of the order of a decibel or so. For analyzed notes this correction was not necessary, as the analyzer effectually excluded the room noise.

It was found that a large part of the sound from these gear units consisted of a group of musical notes. All of the notes from each machine were measured and the analyses of typical machines are shown in Figs. 2, 3, 4 and 5. It will be observed that the sound of each machine presents a distinctive frequency spectrum, with a different number of notes, a somewhat different frequency region, different individual frequencies, and different relative importance of the various notes. These facts are the physical explanation of the individual character of the sound of the separate machines.

Not all of the sound from the gears consisted of musical notes, a considerable part of it being "unpitched sound" of no particular frequency, such as roughness, knocks, or bumps. This sound could not well be measured directly, but it could be computed readily by subtracting the combined sum of the musical notes from the "total noise." Fig. 6 shows the values of total noise, largest single note, combined musical notes, and un-

[2]The 1,000-cycle threshold was taken as 0.00053 bars. See "Useful Constants of Speech and Hearing," by H. Fletcher, *Bell System Technical Journal*, July, 1925, page 375.

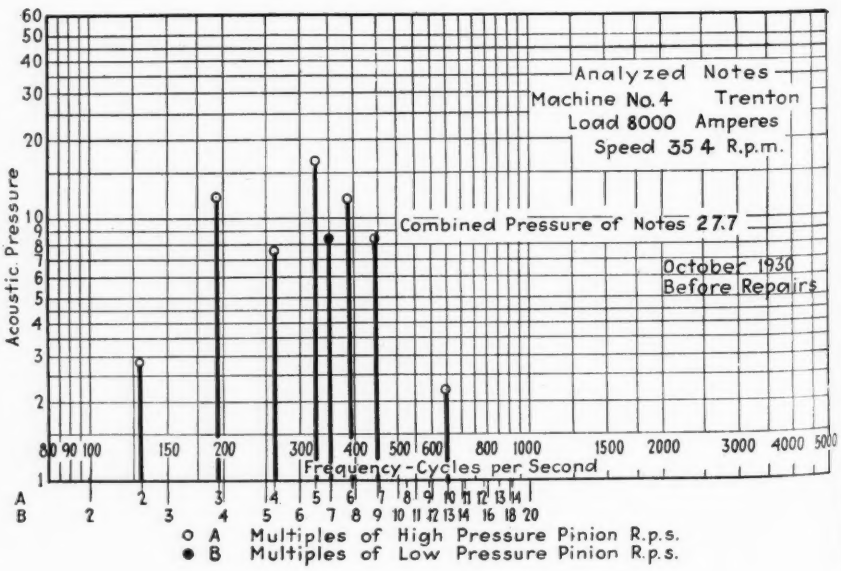


Fig. 3 — Analyzed notes for machine 4, before repairs

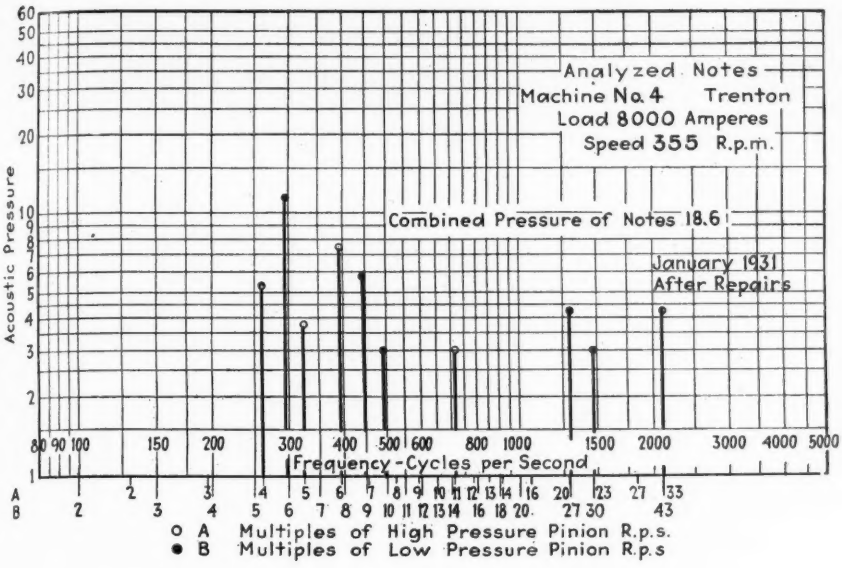


Fig. 4—Machine 4 after repairs. Note great reduction in sound and complete shifting of frequencies

pitched sound for each of the eight gear units measured.

In Fig. 6 the machines are arranged in order of total noise. It appears that most of the differences between the machines lie in the musical notes.

The sound from these gear units varied somewhat with load, but in all cases the changes of noise with load were quite small, and it was decided that satisfactory noise ratings could be obtained at a normal load of 8,000 amperes.

On the basis of the measurements just described it appeared that suitable noise specifications for this type of machine could be written in terms of the four characteristics of the sound which are shown in Fig. 6. Table I shows three possible specifications with varying degrees of severity. [Readers will note that the columns apparently depart from the laws of arithmetic. For example, column B apparently implies that 90 db. + 94 db. = 96 db. That there is no discrepency will be seen by studying the definition of decibels—Editor.]

The first of these specifications would pass only machines equal to or better than the most quiet one of the group tested. The second would pass machines as quiet as the median machine of the group, while the third would pass the six quieter machines, which the plant engineers consider satisfactory, and would reject the two machines which are definitely much noisier than the others. Of course, a complete noise specification would include the location and number of measurement stations used to obtain these averages.

Causes of the Notes

The causes of the various observed notes from the gears could be quite definitely determined by comparing the movements of the various parts of the mechanism with the results of frequency analyses. Table II is an example.

The frequencies of the observed notes (Figs. 2, 3, 4 and 5) were determined from the analyzer settings, while the abscissas marked "multiples of pinion rotation" were computed from tachometer readings of the speed at the time of measurement, together with the above data on the number of teeth on the various gears.

It will be observed that in every case the frequencies of the observed notes corresponded to one of the harmonics of pinion rotation to a surprising degree of accuracy. From this it was possible to determine which part of the machine produced each particular note. Those due to the high-pressure pinion have been marked with an open circle, and those from the low-pressure pinion with a solid circle.

In a few cases both pinions produced harmonics very close to the observed note, so that the source is uncertain, although it is believed that with more care these could be definitely determined.

It was found that (1) the frequencies of the observed notes were not multiples of the tooth contact frequency, nor did they correspond to any integral number of teeth, (2) none of the notes was due to the large gear; (3) the fundamental rotational notes were missing and the first two or three harmonics were usually negligible.

Errors in Tooth Profile

The absence or complete negligibility of the tooth contact frequency and its harmonics was a rather surprising and very important result. This fact proved conclusively

TABLE I — POSSIBLE NOISE SPECIFICATIONS FOR UNITS UNDER TEST

	Equivalent Db. above 1,000-cycle threshold		
	A	B	C
Total noise	95	96	96
Largest single note	84	87	89
Combined musical notes	88	90	94
Unpitched sound	94	94	94
Machines passed, Nos.	1	1, 12, 13, 11	1, 12, 13, 11, 3, 5
Machines failed to pass, Nos.	All others	3, 5, 2, 4	2, 4

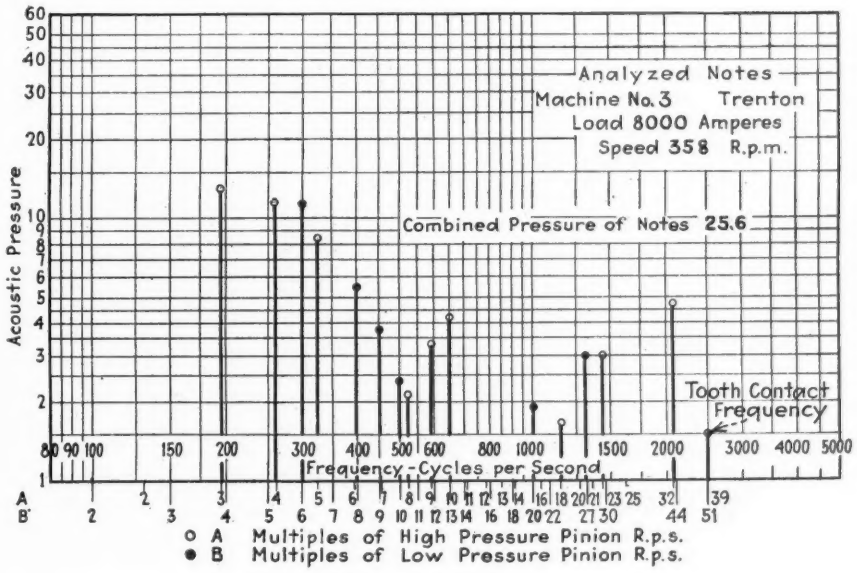


Fig. 5 — Analyzed notes for machine 3

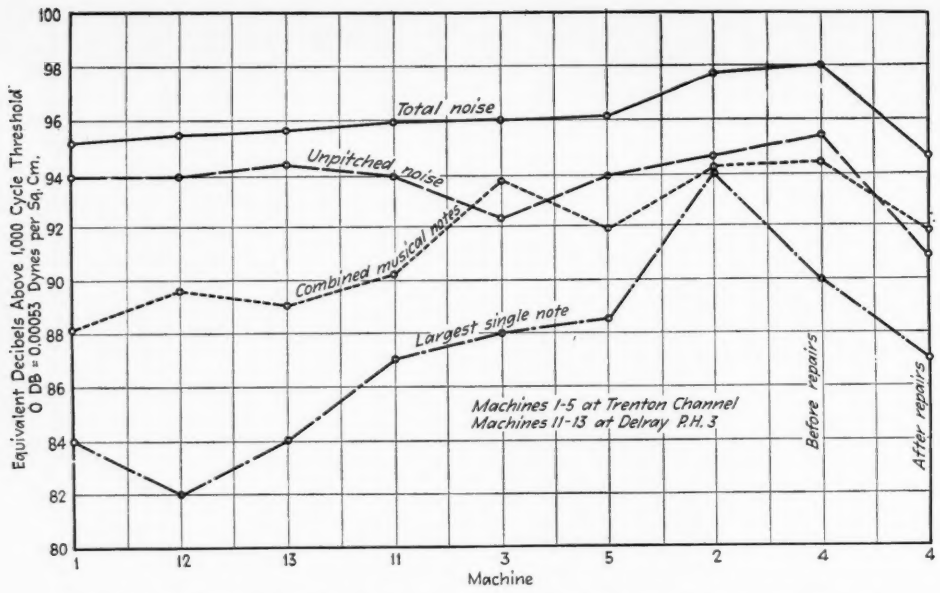


Fig. 6—Relative amounts of "total noise" "largest single note," "combined musical notes" and "unpitched sound" for the machines measured.

that the sound was not due to errors in tooth profile, nor to inaccuracies in alinement which would tend to cause an irregularity with each tooth engagement. Therefore the most common causes of gear noise were eliminated. The fact that none of the notes corresponded to an integral number of teeth proved that the sounds were not due to peculiarities on individual teeth.

The fact that the fundamental rotational frequency notes were absent was indication that the mechanical balance of the various parts was good. There was no evidence that the notes were due to resonance, and accordingly it was concluded that the notes were caused by systematic irregularities in the indexing and tooth spiral. The original source doubtless lay in the gear trains or other means by which these movements were obtained on the machine upon which the pinions were cut.

Following these measurements machine 4 was disassembled for inspection. It was found that the teeth on the bull gear were somewhat rough and pitted, but that no particular regions of unusual contact could be found which could be related to the observed notes. It is believed that at least part of the roughness or unpitched sound was due to this condition.

The pinions showed evidences of abnormal contact in the form of black spots about the diameter of a pea which appeared in groups on the tooth surfaces. These groups did not follow along a given tooth very far, but were spread axially across the face of the pinion. The low-pressure pinion had six of these groups of spots spaced about equally around the periphery. As shown in Fig. 3, the only note of consequence from this pinion was the sixth harmonic. The spots on the high-pressure pinion divided the circumference into fifths, except that one group was missing. This might be expected to give a number of harmonics centering about the fifth, which is exactly the arrangement measured and shown in Fig. 3.

Effect of Repairs on Machine 4

After inspection the gears of machine 4 were returned to the factory for repairs which consisted of taking a fine cut from the sides of the teeth normally in use. Following this the machine was assembled, lapped, run in, and measurements made to determine the effect of the repairs. The frequency analysis after repairs is shown in Fig. 4.

The repairs produced an enormous improvement in the sound of this machine. Before repairs it was the noisiest of the group, while afterward it was the quietest with respect to total noise and unpitched sound, and very satisfactory with regard to musical notes. The reduction in unpitched noise made a marked improvement in the smoothness of the sound.

A comparison of Figs. 3 and 4 shows that the frequency analyses before and after repairs were entirely different. Many of the old notes were removed and new and smaller ones introduced. The important frequency region was shifted, and the relative importance of the various notes was changed. In fact, as far as sound was concerned, it might have been a new machine. This was conclusive evdence that the notes were not due to resonance.

TABLE II — FUNDAMENTAL MACHINE MOVEMENTS OF GEAR UNITS UNDER TEST

At 360 r.p.m.

	R.p.m.	Teeth	Frequency of Fundamental Note Cycles per Second
Output shaft	360	...	6.0
Large gear	360	424	2544.0
Low speed input shaft	2993	...	49.9
Low speed pinion	2993	51	2544.0
High speed input shaft	3914	...	65.2
Highs peed pinion	3914	39	2544.0

This investigation indicates that noise specifications in terms of physical units are feasible for machinery of this type, provided proper care is taken to average out variations due to wave patterns and other causes, and to maintain accurate microphone calibration. It appears that the four characteristics of "total noise," "largest single note," "combined musical notes," and "unpitched sound" can be advantageously used in such specifications.

Frequency analysis to determine the frequncy and the magnitude of the various component notes of the sound is of considerable value both in determining the noise specifications and in determining which particular part of the machine is responsible for the noise, and something of the nature of the defect which produces it.

Steam and Hydro Power In the Philippines

By WALTER BUCHLER*

AT THE time the Philippine Islands were taken over by the United States, Manila had a small power station owned and controlled by a Spanish concern which supplied electric current to the town. This was taken over by the Manila Electric Company in 1903, which continued to use the old plant until a new and more modern one was built.

The new plant is operated by steam and has a generating capacity of 29,500 kw. It is by far the largest power station in the islands.

The same company owns the hydro-electric plant at Botocan and sixteen smaller stations in different parts of the islands. Besides these there are numerous small power sations owned by private companies in other parts of the country. These small plants are driven by Diesel engines ranging from 60 up to 800 horsepower.

The Manila Power Station

The Manila power station is built on an island called Isla Provisor. Dust coal, imported from Manchuria, is floated up to the plant in barges. This fuel, running 11,500 B.t.u. per pound, is stored in yards near the plant. Circulating water for the condensers is taken in on one side of the island and discharged on the other.

The building is of reinforced concrete and steel and is built somewhat stronger than the average power station to allow for earthquakes, which occur now and again in the form of light shocks. The boiler room is open to the surroundings and has more windows and ventilators than have stations in more temperate zones.

The 600-ft. head Botocan river hydro-electric plant is 55 miles by air from Manila, connecting with the steam plant there. It is built of concrete and steel and is equipped with two 10,000-hp. and one 1,000-hp. unit. The system is alternating-current, 13,800-volts, 60-cycles, stepped up to 110,000 volts for transmission to Manila by air line, where it is stepped down to 13,000 volts for local distribution.

A difficulty experienced in the transmission has been due to large bats flying into the wires and short-circuiting them, this trouble occurring mainly in the 13,000-volt system, as the wires are not so far apart as on the 110,000-volt. Another difficulty is caused by flying coconut palm leaves which get across the wires and likewise cause short circuits. To prevent this, as far as possible, trees along the transmission line are trimmed. Typhoons occur between August and December, and as a precaution the towers are built extra strong with heavier steel and more bracing. When this line was first operated, there were several instances of natives interfering with it, presumably to steal copper. One got electrocuted and this automatically put a stop to further interference.

Filipinos Work Under American Direction

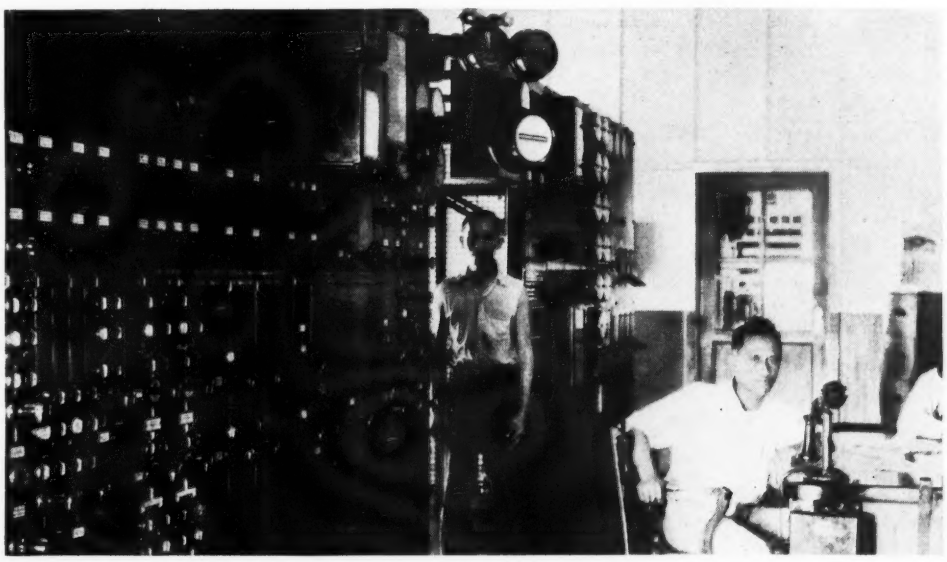
The oilers and stokers at the Manila plant plant are all Filipinos, while the watch engineers are American. The Filipino is satisfactory for all routine work, but the American is generally better in an emergency.

The engineers in charge of the smaller plants up-country are Filipinos with local or American training. All repairs are carried out in the company's own shops, which are equipped with up-to-date machinery and capable of handling turbine blading, as well as other repairs. The hands are Filipinos working under American supervision.

Considerable progress has been made in street and domestic lighting in the Philippines. The people are fond of light and current is cheap. Attractive rates are offered to houses equipped with electric ranges and hot water, and a fully equipped house can get service for 8 centavos (100 centavos = 1 Peso = 50 cents gold) per kilowatt hour. The charge for current for electric lighting is 20 centavos a kilowatt hour. Small houses with but one light pay only 1.10 pesos a month as a flat rate, for in these poor dwelling places it is difficult to place a meter.

Power is being used on an ever-increasing scale for industrial purposes in coconut-oil mills, saw mills, ice plants, cement, and engineering shops. Experiments in electric traffic signals are in progress in Manila and appear to be working satisfactorily.

*Mr. Buchler, an engineer from London, England, recently visited the Philippine Islands and studied power conditions there.



Filipinos on the job at Manila power station

Automatic control for two 3,000-kva. synchronous - condenser motor - generator sets and direct - current feeders

Industrial Plant Synchronous Condensers Automatically Controlled

By F. P. BRIGHTMAN
Industrial Engineering Dept.
General Electric Company

Problems are given to show the possible saving that may be made by the installation of manually controlled and automatically controlled synchronous condensers. The control and protection features of one system of automatic operation are outlined

POOR voltage regulation, excessively high power bills, and overheated apparatus and cables, are attributed frequently to a low system power factor. Such conditions justify the consideration of some means of providing leading reactive kilovolt-amperes for correcting the power factor.

There are two major sources of leading reactive kilovolt-amperes, namely, synchronous equipment and capacitors. Though both have their advantages and disadvantages, the relative merits of the two types of equip- will not be discussed here, as it is the purpose of this article to take up synchronous equipment and its automatic control.

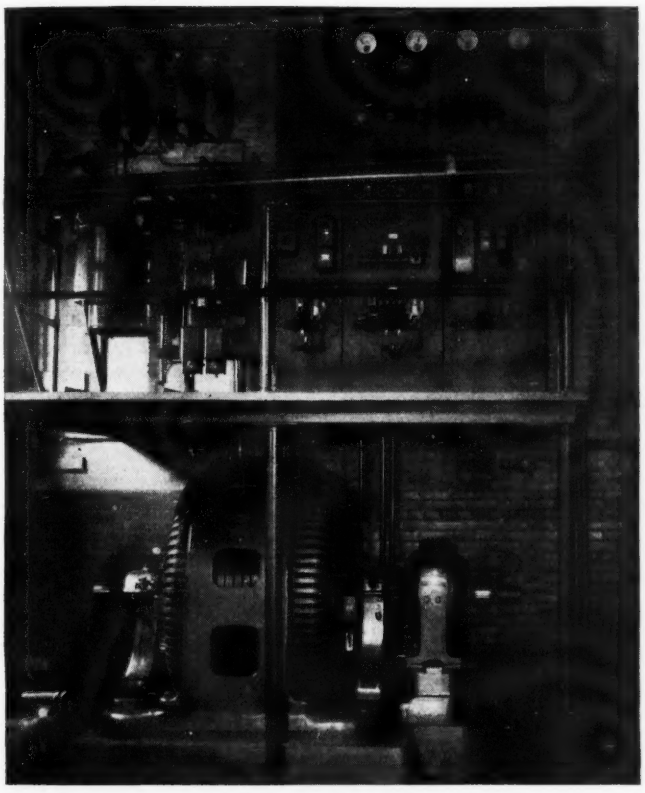
Many industrial plants have a power factor somewhere between 65 to 80 per cent lagging. Some, run considerably better, and others may go even lower. Many of the power companies today include a clause in their power contracts, designed to encourage system power-factor improvement by imposing a penalty on the user for low power factor. This clause may be worded in various ways, sometimes referring specifically to power factor and at other times to kilovolt-ampere demand. If the contract refers to power factor specifically the clause may provide a penalty for each per cent that the purchaser's system falls below a certain power factor, and a bonus for each per cent above it, or a combination of the two. When the demand method is used the charge is a certain sum per month for each kilovolt-ampere of demand, usually based on the maximum metered demand for a given time, during a specified number of months preceding the date of billing. It is obvious that for a load having a lagging power-factor any correction that will bring it nearer to unity will automatically reduce the kilovolt-amperes demand for a given kilowatt load, thereby reducing the demand charge.

Aside from the direct saving in the power bill to be obtained by improving the power factor, there are the benefits to be derived in the form of better voltage regulation and reduction in the heating of various parts of the system for a given useful load. Raising the voltage toward normal increases the speed of induction motors, thereby speeding up production, and it also improves the operation of synchronous equipment. The reduction in heating of various portions of the circuit can be taken

advantage of to increase the system load without increasing the capacity of cables, busbars, transformers, circuit breakers, and other equipment. If, for example, the power factor of a 75 per cent power-factor load is raised to 93 per cent lagging the capacity of the circuit may be increased 24 per cent, and if the power factor is raised to unity the possible increase in capacity is 33⅓ per cent.

As an illustration of the direct saving in the power bill, assume a 2,000-kva., 75 per cent lagging power-factor load. Such a system would require 750 leading kilovolt-amperes to bring the power-factor up to 93 per cent and 1,320 leading kilovolt-amperes to bring it up to unity. An improvement in the power factor from 75 per cent to 93 per cent would permit of a saving of $4,000 per year calculated on the basis of the kilovolt-amperes demand charge of a certain large power company. If the power-factor was raised to unity, the saving would be $5,400 per year.

A 750-kva. synchronous condenser with direct-connected exciter plus manual switchgear equipment, instal-



Automatic control for a 1,000-kva., 2,300-volt synchronous condenser

lation and foundation charges, but not including building, would have a cost of approximately $9,300. Capital charges on the investment, at 15 per cent, plus an energy charge for losses in the machine and the salary of an operator at $35 a week, make an annual total of $3,787. The calculated possible saving by increasing the power factor was $4,000, leaving a net profit of only $213. If a 1,500-kva. condenser is installed to bring the power factor up to unity, the net profit on the same basis would be approximately $937. As the cost of an operator was calculated on the basis of a single shift, it is apparent that the operating cost would increase appreciably, and there would be a considerable sum to be charged against the benefits of power-factor correction if the number of shifts of operators is increased to two or three, as the case may be.

If, however, the switchgear is made automatic, so that an operator is not required, the initial cost of the 750-kva. installation would be increased to approximately $12,790, exclusive of building, but the net profit at the end of the year would be $1,313 compared with $213 for the manual installation. For a 1,500-kva. installation the initial cost would be $16,000 and the saving $2,037 against $937 for a manual installation. It is readily apparent that the financial benefits to be derived from the automatic control increase rapidly if the number of hours of operation is increased so that more than one operator per day is required for the manual station.

Experience has shown that automatic switching equipment can perform the usual functions required to control and protect the machines as well as, or better than, the best human operator. Automatic control has been perfected to such an extent that it is almost uncanny in its performance and almost seems to have the power of thought. It has an important advantage over the man in that it is mechanical. No matter how conscientious a man may be, it is too much to expect that he could or would stand and watch the various instruments and machine temperature indicators continuously.

The major functions to be performed in the control of a machine are starting, stopping and protecting it against any of the numerous difficulties that might be encountered, such as long continued overcurrents, loss of field, or overheated bearings.

The automatic control equipment can be so arranged that it will start the machine at a predetermined time, as indicated by a time switch, by manual closing of the master switch located in the station itself or at some remote point, or by a low-voltage relay indicating that power-factor correction is needed.

With one system of automatic control, when the indication to start is given the starting breaker is closed, energizing the machine from a reduced voltage source, provided the undervoltage relay indicates that the alternating-current voltage is normal. Occasionally full-voltage starting is used, in which case the main running breaker is closed initially.

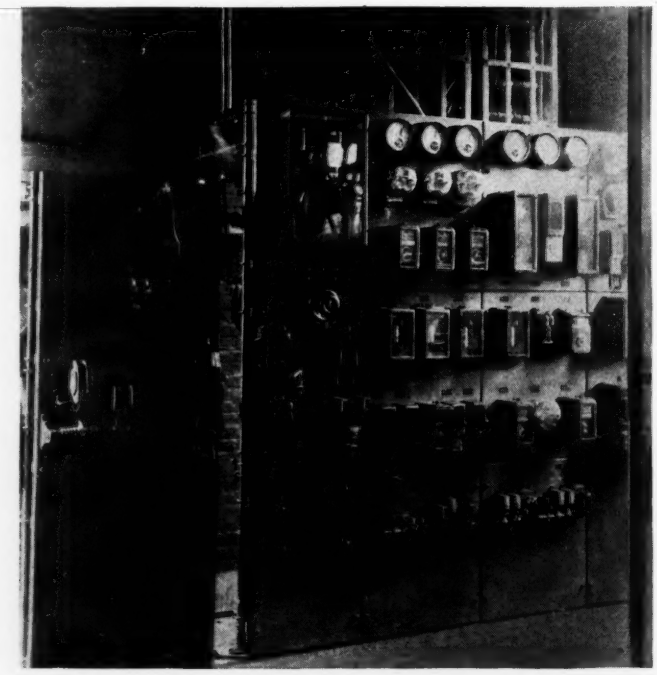
It is customary in manually operated stations to turn the exciter field rheostat to the all-out position to insure prompt voltage build-up so that excitation will be available by the time the condenser is ready to synchronize. With the automatic control a device does this by shorting the rheostat until normal voltage is attained.

An operator when starting a synchronous machine watches for the drop in stator current, which tells him that the condenser is nearly up to synchronous speed and that it is time to apply field. The automatic equipment does exactly the same thing by means of a synchronous speed relay, and causes a contactor to close, energizing the field. Once the field is on and the machine is in step the next operation is to throw it over to full voltage, if reduced-voltage starting has been employed. This operation is performed promptly and correctly by an interlock on the field contactor. The condenser is now on the line and will deliver a fixed amount of leading kilovolt-amperes for straight power-factor correction. If, however, a voltage regulator is included in the control equipment, variable amount of reactive kilovolt-amperes is furnished, so that steady system voltage is maintained and the power factor is automatically held at or near unity.

The equipment may be so arranged that the condenser will run until shut down by the time switch, by manual opening of the master control switch, or by undercurrent accompanied by normal voltage, indicating that the condenser is no longer needed unless some abnormal condition develops.

A field relay keeps a check on the main machine field current just the same as the operator watches the field ammeter to see that all is well. The relay coil is in series with the field and it operates immediately to shut the machine down if the field current fails.

The bearings of rotating machines have to be checked periodically, because serious damage may result if they become too hot. A relay with a sensitive sylphon bulb in the lower half of the bearing provides full protection to them when automatic control is used. If the bearing becomes too hot, the liquid in the bulb vaporizes, and expands the bellows to which the bulb is attached, causing the hand reset contacts to open. Past experience



Automatic control panel for a 7,500-kva., 13,800-volt synchronous condenser

shows that these relays afford excellent protection to the bearings. In most cases the relay operates and shuts down the machine before damage has been done other than that which can be repaired by scraping.

Frequently the load is of such a nature that it is possible to predict when heavy lagging power-factor loads requiring leading reactive kilovolt-amperes from the condenser will occur. In such cases an electric time clock serves as the master device to start and stop the machine, thereby saving power losses. Another common method of providing for automatic starting and stopping of the machine makes use of a voltage relay. Such use is based on the assumption that low voltage indicates a heavy lagging power-factor load requiring condenser's leading kilovolt-amperes; and that high voltage indicates no further need for the condenser because of high voltage due to light load or high power factor. When a voltage relay is used as master device it is customary to introduce a time delay at start and another at shutdown to prevent false operation due to momentary voltage fluctuations.

The more complete equipments include an incomplete start relay which keeps watch during the starting period to insure that the correct sequence is completed within a given time. If for any reason some device fails to function, so that the machine does not come up to speed and go on the line properly, this relay stands ready to take the equipment off the line and hold it off until the station has been inspected to find out what the trouble is. Under certain conditions field-changing contactor may be desirable to furnish the smoothest possible transition from the starting to the running connection by allowing the application of field excitation in two steps.

The principal deciding factors, in the choice of simple elaborate equipment, are the size and value of the condenser itself and the amount of money the purchaser is willing to pay for insurance. There is question as to the suitability or reliability of automatic control, for it has proved itself dependable throughout many years of service.

Effect of Water Level and Rating on Moisture Carryover

TESTS were recently run at the Cambria plant of the Bethlehem Steel Company to determine the effect of steam flow, water level and concentration of solids in the boiler water upon the moisture content of the steam discharged from the boiler. The boilers are of the Stirling type containing 15,287 sq.ft. of heating surface and designed for maximum output of 125,000 lb. of steam per hour at 450 lb. pressure. Integral economizers of 9,872 sq.ft. of heating surface are provided. Blast-furnace gas and coke-oven tar are used as fuel and burned in two gas burners per boiler, combustion being regulated by Smoot control.

Two throttling calorimeters were used, one lagged and the other unlagged. These were mounted on a straight vertical pipe between the boiler outlet and the superheater inlet. Normal readings for both calorimeters were obtained with the blast furnace gas shut off and the boiler banked. The water levels indicated were obtained from level gages which indicated the actual depth of water in the center drum, which readings checked with the gage glass readings within the range of the latter.

The pressure of the steam in the goose-neck between the boiler drum and superheater was determined by referring thermometer readings to steam tables. Moisture results were calculated by the formula.

$$\frac{0.47\ (T - t)}{L} \times 100$$

in which T equals normal temperature of steam at calorimeter exhaust with no steam flow; t equals temperature of calorimeter exhaust obtained during test; and L equals the latent heat at the pressures inside the vertical steam pipe.

The first tests were conducted with a concentration of 2,500 p.p.m., which was maintained constant by continuous-blowdown equipment. The boiler was allowed to reach a stabilized condition with an output of 100,000 lb. of steam per hour and the water level held constant at 13 in. The temperature readings taken under these conditions and the calculated moisture content of the

DATA AND RESULTS OF MOISTURE TESTS

	August 21, 1931						August 21, 1931				
	A	B	C	D	E	F	G	H	I	J	K
Steam flow, lb. per hr.	100,000	25,000	50,000	90,000	105,000	90,000	75,000	100,000	125,000	100,000	100,000
Water level, in.	13	13	25	33	28	13.5	14	13	13	13	19
Steam pressure, lb. per sq.in.	205	190	195	200	205	200	195	200	205	215	210
Steam temperature, deg.	388	384	385	385	387	386	385	386	388	394	392
Lagged calorimeter temperature, deg.	313	312	312	312	313	313	312	313	314	315	314
Unlagged calorimeter temperature, deg.	310	309	309	309	310	310	310	310	310.5	312	311
Moisture lagged calorimeter, per cent	0.034	0.000	0.000	0.022	0.011	0.000	0.022	0.000	0.000	0.056	0.067
Moisture (unlagged calorimeter), per cent	0.034	0.000	0.000	0.022	0.011	0.000	0.000	0.000	0.006	0.056	0.067
Concentration (total)	2,500 parts per million						3,500 parts per million				

steam discharged from the boiler drum are shown in Column A of the table.

The gas flow was then reduced as low as possible, giving a rating of 25,000 lb. of steam per hour. This condition was maintained until the boiler became stabilized before the reading of the calorimeters was made, with the result indicated in Column B. Gas was then fed to the burners as fast as the combustion-control equipment would allow, bringing the rating up to 105,000 lb. per hour in 2½ min. During this quick change from low rating to high the water level rose quickly from a height of 13 in. to 33 in. Two readings were taken during this period, and as indicated in Columns D and E the moisture content rose to 0.022 per cent and 0.011 per cent.

The rating of 105,000 lb. per hour was maintained until the water receded below the top of the glass, when the rating was reduced to 90,000 lb. per hour, and as shown in Column F the moisture content dropped to zero.

A second set of tests was made to determine the effect of boiler water concentration upon the moisture carryover. For these tests the concentration of solids in the boiler water was allowed to increase to 3,500 p.p.m. With the water level maintained at 13 in., moisture readings were made at steady flows of 75,000, 100,000 and 125,000 lb. of steam per hour, the results being indicated in Columns G, H, I and J.

The bypass on the feed-water regulator was then slowly opened and the boiler allowed to fill gradually until the high-water alarm sounded, the steam flow being maintained constant at 100,000 lb. per hour. As indicated in Column K, the moisture content increased to 0.067 per cent.

In both tests the moisture content is well below one-tenth of 1 per cent and is so small that it may possibly be attributed to experimental errors. The tests appear to indicate, however, that the moisture carryover increased rather slightly with increases in rating, but that increased concentration had little effect upon carryover.

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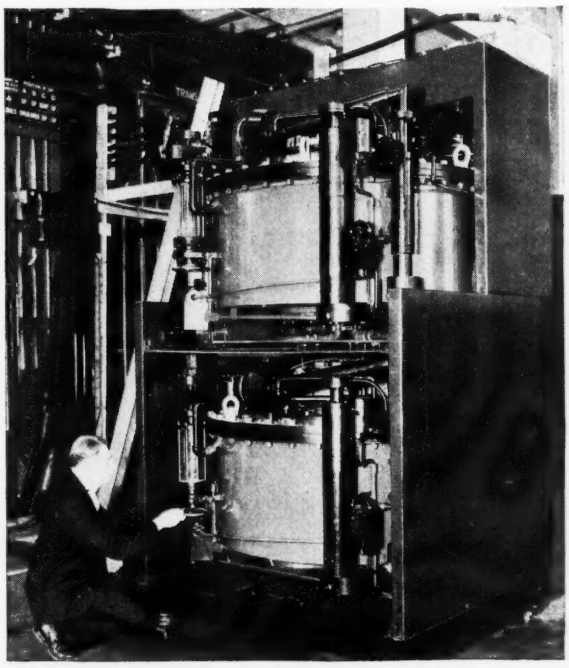
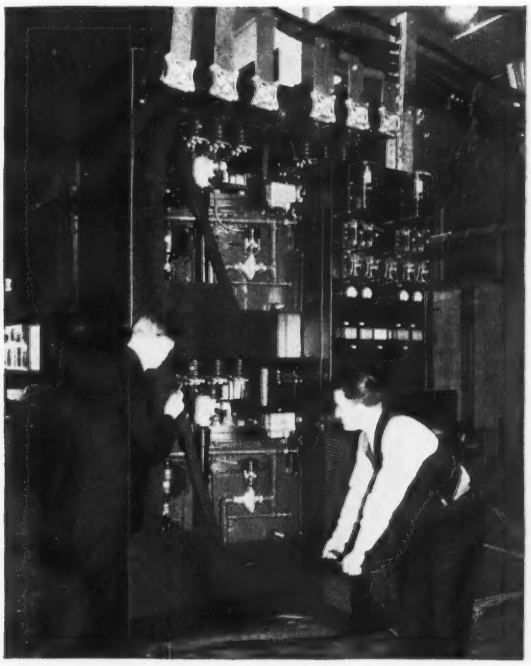
Mercury-Arc Rectifier Made in Two Sections



THE LATEST in mercury are rectifiers, this 1,500-kw. unit on test in Westinghouse laboratories consists of two interchangeable units, rated at 600 volts, 750 kw., mounted on rollers one above the other. The engineer is reading the vacuum in the lower section.



BACK VIEW of the 1,500-kw. sectional rectifier. Turning the hand crank rolls the entire 750-kw. rectifier set free of its connections. The man on the left is watching the contacts disconnect from the power supply as the section is pushed out of position in the assembly.

Material for Diesel Cylinder Liners

By M. E. GREENHOW
Washington Iron Works
Seattle, Wash.

The most essential thing to be considered in the building of diesel engines or any equipment from which satisfactory performance and service is expected is design. The efficient and economical operation of the same equipment however, depends largely on its materials of construction, such as the cylinder liner material.

The great improvement in the structure and physical properties of modern cast iron for cylinders and like parts makes it well worthy of a new name, to distinguish it from the old familiar term "cast iron" and the general conception of the qualities possessed by the metal of several decades ago.

The development in this field in the past ten or twelve years has restored the confidence of the designing engineer to the extent that cast iron is no longer considered a metal to be avoided where possible, but is now recognized as a valuable material for many applications.

Due to its complex composition, equally as much skill and knowledge is essential in producing this material as any other in the metal-working industry. Although the chemical elements, with the exception of the addition of alloys and combinations of alloys, are the same in this new material as in the old cast iron, they have been arranged in difierent proportions and relations one to another so as to effect materially the ultimate results. To this end there must be correct foundry practice, such as melting, molding, gating and risering, all of which contribute to quality of the finished casting and its adaptability to the service for which it is to be used.

There are many different opinions regarding the percentages of the different materials used to make up a mixture for a melt of cast iron. These mixtures may vary from one containing 30 per cent to 60 per cent of one or more grades of pig iron, 40 to 50 per cent-iron scrap, 10 to 40 per cent steel, to a mixture composed almost entirely of steel scrap, or of about 95 per cent steel scrap and 5 per cent in form of ferro-alloys, the latter being added to build up the chemical composition desired in the finished product.

The correction percentages of silicon, sulphur, phosphorous, manganese and carbon are determined by the cross-sectional area and intricacy of design.

Carbon in cast iron exists in two forms, combined carbon or carbide of iron (Fe_3C) and that in the free state, or graphitic carbon.

The existence of carbon in cast iron and the relative amounts of its two forms largely determines the physical properties of the finished product. The other chemical elements are of secondary importance, their chief function being the effect they have on the carbon. Silicon acts as a graphitizer during solidification, while sulphur tends to hold the carbon in solution with the iron. Various alloys are also added for the same purpose. Chromium exerts an influence like sulphur, and nickel exerts the same influence as silicon but is only about one-fifth as active.

An iron containing its chemical constituents in correct amounts and in a definite relation one to another, and melted under proper supervision and according to correct furnace practice, will produce castings in which the graphitic, or free carbon, crystals are of a size and shape, uniformly distributed through the matrix, to increase materially the strength of the material. The crystals will have a definite influence on the iron's ability to furnish a good surface for lubrication in case of the reciprocating parts of internal-combustion engines, and, consequently, to resist wear to high degree.

Cast irons are now regularly produced that will consistently run 50,000 lb. per square inch tensile strength. In most cases this extremely high strength is not considered essential to the satisfactory performance of an engine part in service and some strength is therefore sacrifice for machinability.

In Fig. 1 is shown a micrograph of the fractured end of a segment of a cylinder liner, normal size. The open porous condition of the facture is indicative of a coarse irregular graphitic carbon precipitate, which contributes to the non-uniformity of hardness, as later shown. Indentations made by the Brinell machine gave hardness numbers from 137 to 163. On five impressions taken, a difference of 26 points was recorded between the low and high readings, the variation in hardness being 20 per cent.

The photomicrograph in Fig. 2 is of an unetched specimen magnified 50 diam. This shows the coarse, irregular, needlelike graphite flakes which break up the continuity of the matrix, producing a weak, soft gray iron.

TABLE I—CHEMICAL ANALYSIS OF CAST IRON

Element	Per Cent
Silicon	1.50
Sulphur	0.080
Phosphorus	0.30
Manganese	0.55
Total carbon	3.40
Combined carbon	0.62
Nickel	None
Chromium	None
Molybdenum	None

Fig. 1 (Top)—Photomicrograph of coarse-grain cast iron

Fig. 2 (Center)—Same iron as in Fig. 1 but magnified 50 dia.

Fig. 3 (Bottom)—The metal in Fig. 2 has been etched and magnified 50 dia.

The same metal etched and magnified at 50 diam. appears in Fig. 3. The ground mass is pearlite interspersed with white concretions, which are the carbides. Carbide is the hardest constituent in cast iron and when in excess makes machining difficult, leaving the finished surface with minute projections which exert a cutting action on piston and rings when the casting is used for a cylinder liner.

The chemical composition of the metal shown in Figs. 1 to 3 is as given in Table I.

In Fig. 4 is shown the micrograph of the fractured end of the segment of a diesel cylinder liner of high-test alloy cast iron normal size. The dense, close-grain structure is indicative of the condition of carbon precipitate which contributes to the uniformity of hardness. The indentations made by the Brinell machine gave hardness numbers which on seven impressions ranged from 207 to 218, a difference of 11 points.

A specimen taken from Fig. 4 unetched when magnified 50 diam. gave Fig. 5, which shows finely divided graphite crystals frequently nodular in shape and uniformly distributed throughout the matrix, precipitated in a dendritic arrangement. This is characteristic of an iron with high strength values.

The photomicrograph, Fig. 6, is number Fig. 5 etched and magnified 140 diameters. The graphite constituent found in Fig. 5 is still shown in finely divided crystals, uninformly distributed. The ground mass is a pearlitic-sorbitic matrix free from carbides or the formation of hard spots.

The chemical analysis of this material is given in Table II.

The physical properties as determined from the standard American Society for Testing Materials arbitration bar were: transverse strength, 4,980 lb.; deflection, 12 in. centers, 0.115 in.; tensile strength, 43,564 lb.; and Brinell hardness, No. 234.

The samples shown in Figs. 4 to 6 and the test bar were annealed to remove casting strains and prevent distortion in service when operating intermittently at elevated temperatures. When quenched in oil at 1,525 deg. F. and drawn at 1,350 deg. F. the structure of this same material gave the photomicrograph reproduced in Fig. 7. This material was made in an electric furnace where close control of its composition was maintained during the entire melting period, check analyses being made to determine what adjustments are necessary. Any correction was made in the furnace and heating continued until the proper pouring temperature was attained.

Quite an interesting study of the effect of wear on a diesel cylinder liner may be made from Figs. 8 and 9. It is clearly evident that the material had been made without much concern as to its satisfactory performance when used as an engine cylinder liner.

These specimens were taken from a cylinder liner discarded on account of excessive wear. The specimen in Fig. 8. was photographed at 150 diam. without any preparation other than cleansing with gasoline. It shows the wall to be worn down to the hard phosphide eutectoid, or steadite, areas. The free, or graphitic carbon and the pearlitic matrix, which are the softer and more uniform areas of the metal, have been worn away by the action of the piston rings. This left the bright areas, the hard phosphide network, exposed, which action is frequently the cause of cutting and scoring.

The Specimen in Fig. 9 was photographed at 100 diam. after etching to develop its structure. It shows more prominently the character of its structure. The long dark areas are graphitic carbon and the white mottled areas are the phosphide eutectoid, or steadite, which is the network exposed in Fig. 8. The dark gray ground mass is pearlite. This material is obviously of a soft weak gray iron.

In spite of the progress made during the past few years in the development of higher-grade cast irons, it is very probable that in the next few years still greater advancement may be through the introduction of new alloys, combinations of alloys and special heat treatments.

TABLE II—ANALYSIS OF ALLOY CAST IRON

Element	Per Cent
Silicon	1.67
Sulphur	0.031
Phosphorus	0.13
Manganese	0.77
Total carbon	2.97
Combined carbon	0.60
Nickel	1.50
Chromium	0.26

Fig. 4 (Top)—Fractured end of alloy cast iron dia.

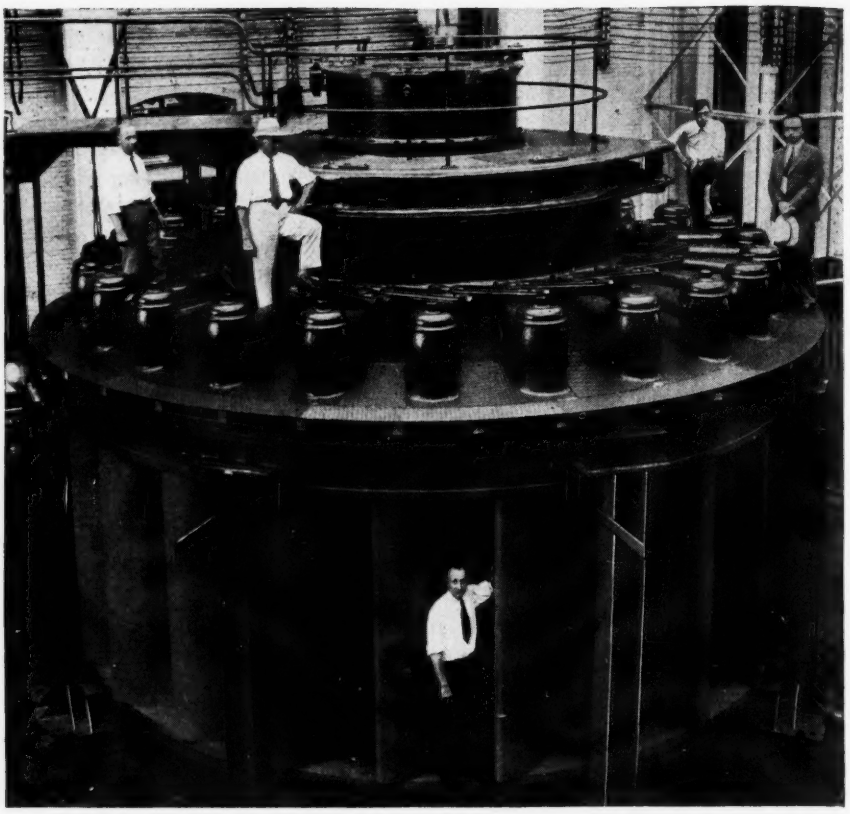
Fig. 5 (Center)—An unetched specimen from Fig. 4 magnified 50 dia.

Fig. 6 (Bottom)—Same as Fig. 3 but etched and magnified 140 dia.

Fig. 7—The metal of Fig. 4 after oil quenching

Fig. 8 (Left)—A cast iron photographed to 150 dia.

Fig. 9 (Right)—The same metal as Fig. 8 etched and photographed at 100 dia.



Wicket-gate assembly for the 57,000-hp. turbine installed in Spier Falls plant

Controlling Wicket-Gate Leakage on 57,000-Hp. Spier Falls Turbine

Wicket-gate leakage on turbine operating under 81-ft. head was kept to less than 0.1 of one per cent of the unit's rated discharge, by a special design for adjusting the clearance at the ends of the gates

By R. V. TERRY
Hydraulic Engineer
Newport News Shipbuilding & Dry Dock Co.

HYDRAULIC TURBINE units are often operated only during peak loads, for a relatively small part of the day. During a large portion of the day they are either operated as synchronous condensers or shut down. In many cases the head gates are left open in order that the unit may be put into service in a minimum of time. Under these conditions of operation it is important that the turbine leakage with the wicket gates closed be as small as practicable in order that serious losses in water will not occur.

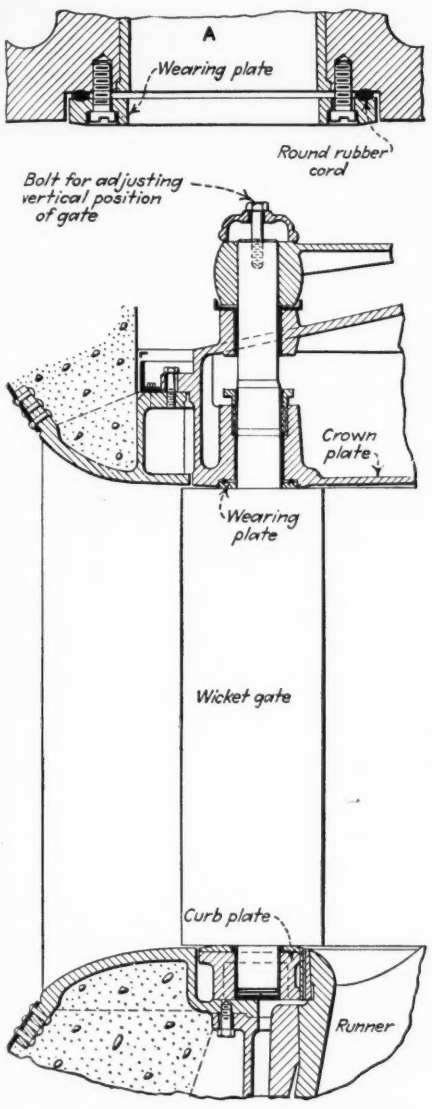
The 57,000-hp. turbine installed in 1930 in the Spier Falls plant addition by the New York Power & Light Corporation has 24 wicket gates 7 ft. 2.5 in. long, pivoted on a gate circle 20 ft. 2 in. diameter. About 300 linear feet of gate clearance is involved, 170 ft. between gates and 130 ft. at top and bottom of gates. With such a unit it will be appreciated that the leakage loss might be very large, perhaps from 100 to 200 sec.-ft., with only a moderate amount of clearance.

The clearance between gates can be made negligible by proper care in the machining and erection of parts. Two important precautions are necessary in machining. The contacting surfaces must be machined parallel with the axis of the stem. Corresponding curb and crown-plate bearings must be bored concentric so that the contacting surfaces of adjacent gates will be parallel when the gates are closed. The angular position of each gate is adjusted after installation by the usual adjustable link so that all gates contact uniformly. The stroke of the servomotors is adjusted to pinch slightly the gates in the closed position to offset the tendency to spring open due to water pressure. The gates are locked in the closed position by a horseshoe-shaped collar inserted between the servomotor crosshead and a large nut on one of the connecting rods.

It is, however, the clearance at the ends of the gates which is usually more difficult to control. When the customary turbine construction is followed it is necessary that a clearance be provided at the ends of the gates so that they will rotate freely without frictional contact with the crown and curb plates. There are several causes which produce inaccuracies in the construction of the parts which affect the clearance, which inaccuracies are very difficult to remedy after the turbine has been installed. One of these causes results from the accumulative effect of the tolerances necessary in machine-shop practice. Another results from slight distortions

which take place when castings are aging. Still another cause is due to the indeterminate amounts of deflection in the component parts of a turbine, owing to the superimposed weights sustained by those parts when the turbine is finally installed and put in operation. It is therefore usually necessary to provide considerably more clearance at the ends of the gates than would seem to be required in the design of the turbine, to prevent any binding action. Such a clearance might result in an excessive amount of leakage, with a corresponding loss in power output from the plant.

The Spier Falls turbine is provided with a simple means for adjusting the clearance at the ends of the gates after installation, as shown in the drawing. The crown-plate wearing plate opposite the upper ends of the gates is made relatively thin, so that it is somewhat flexible. Round rubber cords are inserted in retaining grooves between the wearing plate and crown plate. These cords not only serve to prevent leakage between the wearing plate and crown plate, but form a resilient means for urging the wearing plate toward the upper ends of the gates. When first installed the cords are tightly compressed by the screws holding the wearing ring in place; consequently, a relatively large clearance exists at the top ends of the gates. Each gate is adjusted vertically by a bolt at the upper end of the stem until it just swings free of the curb plate by a few thousandths of an inch. The wearing-ring screws are then backed out, the compressed cord helping to force the ring downward, thereby reducing the gate clearance. In this manner the clearance at the ends of the gates may be adjusted to an extremely small amount to control the leakage loss. Even if the gates should touch the wearing plate, the flexibility of the structure acts to prevent any undue amount of binding action.



One of the gates in place on the Spier Falls turbine. *A* is an enlarged section through wicket-gate wearing plate

The practicability of this method of adjustment to control wicket-gate leakage was amply demonstrated by the results obtained on the Spier Falls turbine. The gate leakage under the normal head of 81 ft. was found to be only 5.4 sec.-ft., which is substantially less than 0.1 of one per cent of the rated discharge of the unit. So far as the writer is aware, this is the lowest hydraulic turbine gate leakage on record. It is gratifying to find that such results could be obtained by the use of an arrangement employing no additional parts except the round rubber cord and without taking any exceptional precautions in connection with the shop and field erection work.

▼

Hard-Facing High-Pressure Valves

A LARGE wall-board manufacturing company in the South that operates its boilers under a pressure of 1,200 lb. per square inch observed that the valves on its duplex boiler feed pumps had a comparatively short life at this high pressure. Records of the life of these valves showed that after 500 hr. of operation it became necessary to replace them because of deep cuts on the valve seats.

The company decided to hard-face the wearing surfaces of the valves and seats. The valve seats, approximately 2 in. in diameter and $\frac{1}{4}$ in. thick were made in two sections. These seats were covered with a thin layer of Stellite by means of the oxyacetylene welding process and ground to shape.

It was found that these hard-faced valves operated 5,000 hr. before it became necessary to rebuild them. After this period of time, building up was necessary, not because of cuts on the valve seats, but because the constant hammering tended to mushroom the metal that formed the base for the hard-faced disk seat.

A study of this situation revealed that the use of a harder and tougher base metal and a thicker deposit of hard-facing material would remedy the difficulty so that the hard-surfaced seats would increase their life ratio over steel by even more than 10 to 1.

This novel application of hard-facing, which was originated at this plant, has proved so satisfactory that the practice has become standard in this company— *Oxyacetylene Tips.*

▼

THE distribution of coal to bunkers is almost always accompanied by a great amount of dust which settles on the bunker room floor and the equipment that may be located there. While this dust does not constitute any particular hazard, it nevertheless makes for difficult housekeeping, and is extremely unpleasant for those whose job it is to operate the coal-distributing equipment. Where a covered screw conveyor is used for distributing the coal over a bunker, this dust may be practically eliminated by admitting a relatively small amount of low-pressure steam into the housing of the conveyor. The amount admitted need only be enough so that a small whiff of it may be seen coming out of the far end of the conveyor. The use of steam for settling dust is just as effective in a vertical bucket conveyor, an apron conveyor of a track hopper, or a coal crusher as it is in the screw conveyor.

An Analysis of Power and Heat Supply for Office Buildings

An economic study of electrical and heating loads of typical office buildings based on conditions in New York City. Consideration is given to the following solutions: (1) purchase of both steam and electricity, (2) purchased steam and steam engines, (3) boilers and steam engines, (4) boilers with both steam and diesel engines, (5) low pressure heating steam and diesel engines

By L. E. HABBEN*

IN SOME cases there are unusual considerations entering into the problem of power supply to an office building. With very tall or tower buildings, such as the Empire State, the Chrysler or the Bank of Manhattan (all in New York City) if a steam-generating plant be installed the smoke stack must be run inside the building, reducing the rentable area on each floor and adding to its cost by the unnecessary height. Obviously, a stack cannot be run outside the building and carried up for only part of the distance, or the upper portion of the property might be rendered unfit for occupation, so the very height of a building may be a big factor in turning to purchased power.

When a building is built for speculative purposes, the primary object is to build it as cheaply as possible; therefore such an additional investment as a power plant is often ruled out at the beginning, and the operating costs, at least to the builder, become of secondary importance.

The only justification for the individual plant is when steam and electricity can be generated more cheaply than they can be purchased, and when steam-electric sets are installed with the exhaust used for heating economical generation is, in most cases, possible only when the steam and electrical loads coincide fairly closely in amount and vary together. Measured over the twenty-four hours, it is quite possible to have a heating load equivalent to the exhaust from the steam-driven generator supplying the electric power, yet it may be a very wasteful operating condition. Hence, monthly, weekly or even daily figures of steam and electric power consumption may be misleading. When investigating the advisability of the individual plant, it is therefore important to ascertain as accurately as possible how these loads will vary over the twenty-four hours.

*Formerly with Lockwood Greene & Company; McClellan & Junkersfeld; Ford, Bacon & Davis; and the Electric Bond & Share Company.

There seems to be a great lack of accurate data concerning this hour-to-hour demand. The utility companies are, naturally enough, interested in selling power, and the property owners are primarily concerned in obtaining the most advantageous contract, the hourly use of such power being of little interest to either party, unless it is purchased upon a maximum-demand basis, in which case the utility company will put in a demand meter.

Lighting, which forms the greater part of the electric load in an office building, will be governed to a certain extent by the intensity of daylight, but not to such an extent as might be expected. While daylight affects the electric load, another factor modifies the heating requirements, which is of course the outside temperature; therefore the peak load for electricity is as likely to occur in summer as in winter, but the maximum demand for steam will occur only in winter.

Electric Loads

Even in buildings of the same type the electric requirements show wide variation. Consider two of the largest skyscrapers in New York, the Chrysler Building and the Bank of Manhattan, inasmuch as these are both tower buildings and are used for general offices. One would expect to find the electric load, that is, the watts per square foot of floor area, very nearly the same for each building, yet there is sufficient difference to render the heat balance for one building useless if applied to the other.

Two curves were made up for each month from the

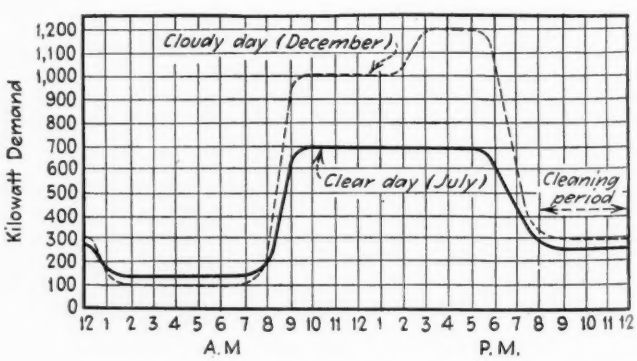


Fig. 1—Daily electrical load of Chrysler Building

maximum-demand meters of both buildings over a period from July, 1930, to February, 1931. One was a maximum demand and the other an average demand curve. Figs. 1 and 2 represent typical curves for a clear day in July and a cloudy day in December for these buildings, which give a good idea of the variation in load to be expected, from average to maximum conditions in each case.

Referring to Fig. 1, it will be seen that the demand in the Chrysler Building for a clear day in July was 700 kw. and for a cloudy day in December, 1,000 kw., increasing to 1,200 kw. as daylight failed. There was also a 1,000-kw. demand for a cloudy July day. Fig. 2 shows that the demand of the Bank of Manhattan was 1,150 kw. for a clear July day, and 1,200 kw. for a cloudy day in December. There was also a 1,190-kw. demand for a cloudy July day. This would indicate that the intensity of daylight has little effect upon the Bank of

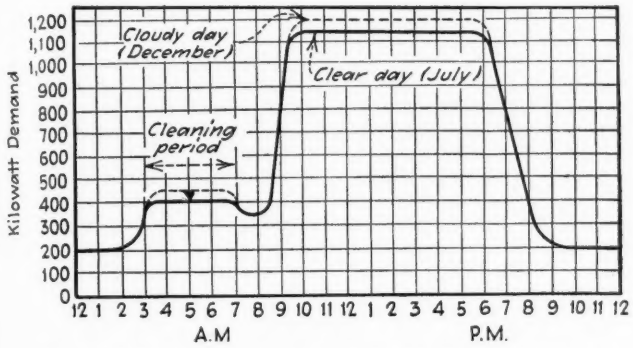


Fig. 2—Daily electrical load of Bank of Manhattan Building

Manhattan electric load, but has an appreciable influence in the Chrysler Building.

TABLE I

Building	1	2	3	4	5
Total, sq.ft.	1,160,000	800,000	858,000	457,000	403,000
Max. load, kw.	1,100	1,200	1,250	500	460
Watts per sq.ft.	0.95	1.5	1.46	1.1	1.14

Note—Buildings No. 4 and 5 watts per square foot for lighting only, plunger elevators still operating.

The answer to this is to be found in the relative locations of the two buildings, the Bank of Manhattan is situated in the middle of a block and shielded on the south by other tall buildings, while the Chrysler is located upon an unobstructed corner. The electric load, therefore, will vary according to the amount of daylight which can be utilized.

The Chrysler Building has an approximate floor area of 1,160,000 sq.ft. and the Bank of Manhattan approximately 800,000 sq.ft. If the total electric load is divided by the total floor area, the result will give the electric load in watts per square foot.

	Chrysler Building	Bank of Manhattan
Clear	0.6	1.44
Cloudy	1.04	1.5

If it is also considered that approximately 85 per cent of the space in the Chrysler Building and less than 66 per cent of that in the Bank of Manhattan was occupied when these curves were taken, the discrepancy is even more marked.

Table I gives comparative data from five buildings in New York in which records were kept of the hour-to-hour demand.

Unless the building is exceptionally well located and designed, it would seem advisible to assume that daylight has little effect upon the load, for it will be found that only those people actually in front of windows will dispense with artificial light, for even when the daylight is intense electric light will be used to reduce shadows.

For the electric load, then, when considering the typical building, it may be assumed for heat-balance purposes that the maximum load will be 1.5 watts per square foot of total floor area; for sudden peaks, an installed capacity of 1.75 watts per square foot, and for nights and Sundays, about 0.2 watts.

Steam Requirements

The steam requirements for office buildings also show considerable variation but are subject to closer estimate than the electric load. The steam consumption for a building may be fairly closely approximated by multiplying the cubic contents (in cubic feet) by a constant which will give the steam used for heating during the heating season. This constant is different, of course, for different types of buildings. For the class under consideration it will vary from 5 to 6. If the total equivalent direct radiation is known, this radiation multiplied by 400 to 500, according to the service expected, is another way of obtaining the heating requirements.

Of the total seasonal requirements, approximately 6 per cent will be used in October, 8 per cent in November, 16 per cent in December, 20 per cent in January, 20 per cent in February, 15 per cent in March, 10 per cent in April and 5 per cent in May. On this basis if the exhaust from the steam-electric sets just balances the heating load in January and February there will be a loss of steam to the atmosphere at all other times when the engines are running. Therefore, the maximum heating requirements should be considerably more than the available heat in the engine exhaust.

Taking now a typical office building of twenty stories, 12,500 sq.ft. per floor, the cubical contents for 10-ft. floor-to-floor height will be 2,500,000 cu.ft., and from

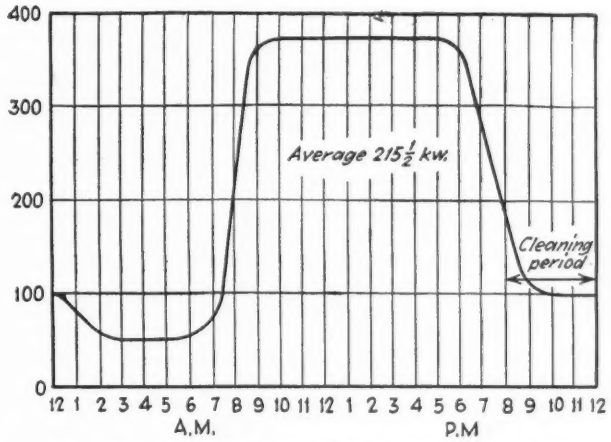


Fig. 3—Typical electrical load for an office building

the previous figures obtained the maximum load will be 375 kw. and the installed capacity around 450 kw. The steam requirements will be $2{,}500{,}000 \times 5\frac{1}{2} = 13{,}750{,}000$ lb. for heating, and 3,120,000 lb. for hot water (taken at 10,000 lb. per day) or a total of 16,870,000 lb. per year. The average monthly consumption for Dec., Jan., Feb. and Mar. will be approximately 2,700,000 pounds.

The average monthly consumption for the remaining portion of the heating season will be 1,257,000 lb., and for the four summer months about 260,000.

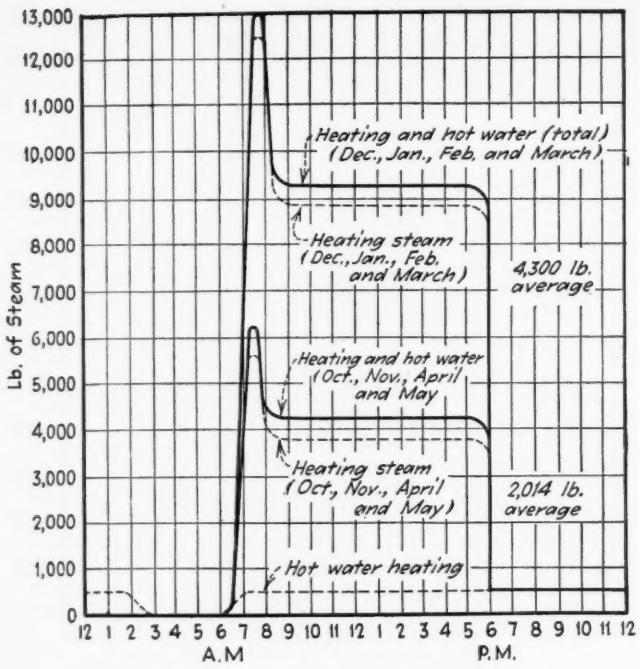

Heating and hot water (total) (Dec., Jan., Feb. and March)
Heating steam (Dec., Jan., Feb. and March)
4,300 lb. average
Heating and hot water (Oct., Nov., April and May
Heating steam (Oct., Nov., April and May)
2,014 lb. average
Hot water heating
Lb. of Steam
A.M
P.M.

Fig. 4—Typical steam load for an office building

The curves of Figs. 3 and 4 indicate typical electric and steam loads for an office building. The heating precedes the electric load, of course, and rises to a sharp peak due to cold risers and radiators, the curve dies away very rapidly when the fires are banked at 5 o'clock. The hot water is supposed to be a steady load of 500 lb. per hour for twenty hours per day. This is not strictly accurate, but no great error is introduced by considering it so. The electric load curve dies away more slowly than the steam, due to some of the occupants working after hours. At 8 o'clock the cleaning period begins and continues until around midnight.

In the following calculations the night load is taken to average 75 kw., the Sunday load 50 kw. and a month to be twenty-six full working days.

If this electric power (1,672,000 kw.hr. per year, see Fig. 3) were purchased according to the New York Edison Company's Wholesale Service Classification No. 3 it would amount to $43,000 per year.[1]

If the steam were purchased according to the New York Steam Corporation's Service Classification No. 3 it would amount to $14,000 per year (see footnote) making a total annual payment of $57,000 for power and steam.

The following combinations will be discussed:—

A—Purchased steam with steam-electric sets.
B—Boilers and steam-electric sets.
C—Boiler plant with steam-electric and diesel-electric sets.
D—Low-pressure heating with diesel-electric sets.

A—PURCHASED STEAM WITH STEAM-ELECTRIC SETS

For this condition, the following have been assumed:

1. Steam conditions at the throttle, 125 lb. saturated.
2. Vertical uniflow engines, one 250-kw., one 200-kw.
3. Average water rate of engines, 35 lb. per kw.-hr.
4. Heating system operating on 2 lb.

From Fig. 5, the average hourly steam consumption for the winter months is 7,900 lb. per twenty-four hours. The average hourly steam consumption for the remaining 8 mo. is 7,600 lb. Sundays will need 1,750 lb. per hr.

The total amount of steam purchased during the year will be 60,000,000 lb., or an average of 5,000,000 lb. per month.

With this quantity it would be advisable to buy under a contract similar to the New York Steam Corporation's Annual Power Service Classification No. 2, which, with a monthly demand of 5,000,000 lb., would amount to $37,200 per year.

Investment costs:

1 250-kw. uniflow engine set	$20,000
1 200-kw. uniflow engine set	16,000
Foundations	4,500
Piping	2,000
Switchboard and electric connections	3,000
	$45,500

Operating costs:

Interest, depreciation, etc., 13 per cent	$5,900
Labor	10,000
Steam	37,200
Lubricating oil	400
	$53,500

Cost of purchased steam and electricity	$57,000
Operating costs, purchased steam only	53,500
Saving	$3,500

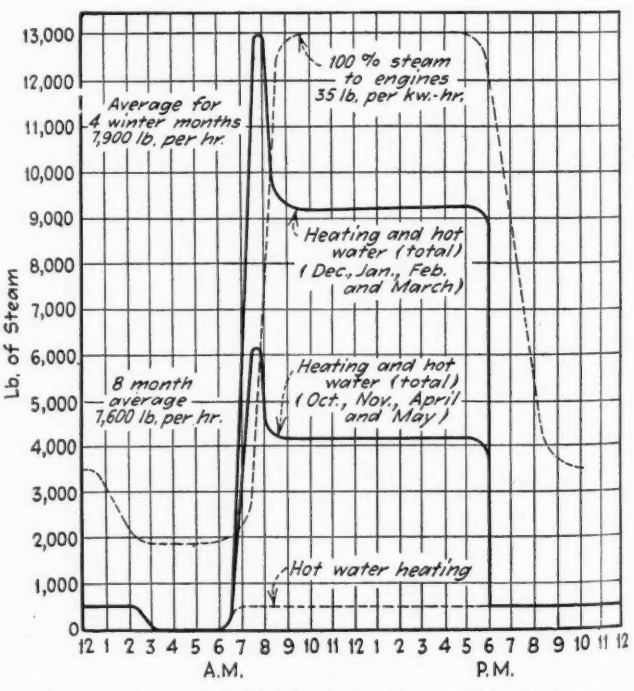

100 % steam to engines 35 lb. per kw.-hr.
Average for 4 winter months 7,900 lb. per hr.
Heating and hot water (total) (Dec., Jan., Feb. and March)
8 month average 7,600 lb. per hr.
Heating and hot water (total) (Oct., Nov., April and May)
Hot water heating
Lb. of Steam
A.M.
P.M.

Fig. 5—Steam and electric loads, with purchased steam and steam engines

[1]The New York Edison Company's Wholesale Classification No. 3 is as follows:

	Kw.-Hr. per Year	Cents per Kw.-Hr.
For the first	75,000	5
For the next	100,000	4
For the next	150,000	3
For the next	775,000	2½
In excess of	1,100,000	2

The New York Steam Corporation's Service Classification No. 3 is as follows:

	Lb. per Month	Per 1,000 Lb.
For the first	500,000	$1.00
For the next	3,500,000	0.75
In excess of	4,000,000	0.70

The New York Steam Corporation's Service Classification No. 2 is as follows:

For the first 250,000 lb. of the designated monthly demand	$1.00 per 1,000 lb.
For the balance of the designated monthly demand	0.60 per 1,000 lb.

Minimum charge of 250,000 lb. per month.

There is the useual coal clause in each of the above contracts which has not been considered here.

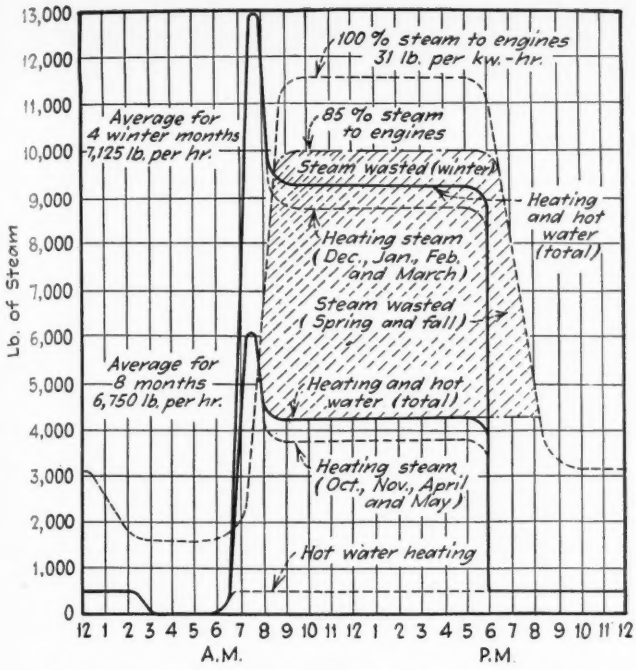


Fig. 6—Steam and electric load, boiler plant with steam engines

B—BOILER PLANT AND STEAM-ELECTRIC SETS

For this condition, the following have been assumed:

1. Steam at throttle, 150 lb. gage 50 deg. superheat.
2. Two 2,000-sq.ft. boilers with under feed stokers.
3. Vertical uniflow engine sets, 1 250-kw., 1 200-kw.
4. Bituminous coal, 13,500 B.t.u. $4.75 per 2,000 lb.
5. Boiler efficiency 75 per cent.
6. Water rate of engines, 31 lb. per kw.-hr.
7. Boiler feed temperature, 197 deg.
8. Heating system operating on 2 lb. gage.

The above steam conditions were taken to reduce the loss of exhaust during the heating period.

From curves on Fig. 6, the amount of steam required is found to be: For the four winter months, an average hourly consumption of 7,125 lb. For the remaining eight months, an average hourly consumption of 6,750 lb. Sundays will require 1,550 lb. per hour, a total of 53,530,000 lb. of steam per year. The boiler will evaporate 1,000 lb. of steam per 105 lb. of coal. The yearly coal consumption will be 5,600,000 lb. = $13,300.

Investment costs:

Two 2,000 sq.ft. boilers	$10,000
Two superheaters	1,500
Feed pumps and feed water heater	1,500
Blowers and stokers	4,000
Breeching	1,000
Foundations	500
One 250-kw. uniflow engine set	20,000
One 200-kw. uniflow engine set	16,000
Foundations	4,500
Piping	4,000
Switchboard and electric connections	3,000
	$66,000

Operating costs and fixed charges:

	Per Year
Interest, depreciation, etc., 13 per cent	$8,600
Labor	14,000
Coal	13,300
Make-up water and feed treatment	400
Lubricating oil	400
Ash removal	450
	$37,150

	Per Year
Cost of purchased steam and electricity	$57,000
Operating costs and fixed charges, boiler plant and steam engine sets	37,150
Saving	$19,850

In the above case, it will be noted that under "operating costs" there is an item for make-up water and feed treatment, because there is a considerable quantity of steam wasted, consequently make-up water must be purchased and treated before being used.

This does not occur under any other scheme, because there is practically no waste, all the steam generated being condensed and returned to the boilers (except of course, in Scheme A); therefore little make-up will be required and no treatment necessary.

The amount of steam wasted is indicated in Fig. 6, where 85 per cent of the exhaust from the engines has been figured as being available for the heating system. There will be no waste steam during the nights or on Sundays, as the heating system will condense it then.

The cost of feed water has been figured at $1 per 1,000 cu.ft. and treatment at 0.3c. per 1,000 gallons.

C—BOILER PLANT WITH STEAM AND DIESEL SETS

For this condition, the following have been assumed:

1. Steam conditions at throttle, 150 lb. gage, saturated.
2. Two 1000-sq.ft. boilers with underfeed stokers.
3. One—200-kw. uniflow engine set.
4. One—250-kw. diesel-electric set.
5. Bituminous coal, 13,500 B.t.u. $4.75 per 2,000 lb.
6. Boiler efficiency, 75 per cent.
7. Water rate of engine, 33 lb. per kw.-hr.
8. Average kilowatt-hours by diesel set per gallon of fuel oil, 11.
9. Boiler feed temperature, 197 deg.
10. Heating system operating on 2 lb. gage.

The load may be assumed as divided between the two machines as follows:

	Uniflow Kw.	Diesel, Kw.
a. Daylight Dec. to March	200	175
b. Daylight Oct., Nov., April and May	150	225
c. Daylight June to Oct.	125	250
d. Nights all the year	0	75
e. Sundays all the year	0	50

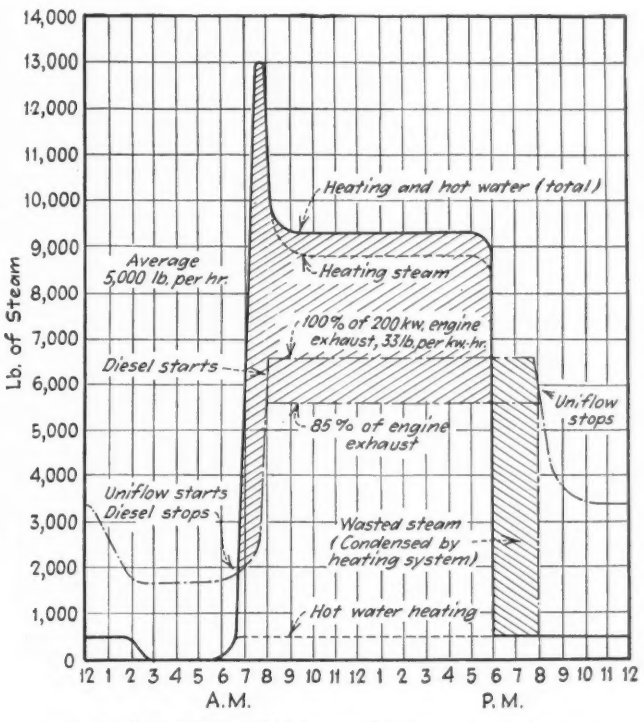


Fig. 7—Maximum heating conditions (Dec. to March) boiler plant with both steam and diesel engines

From the curves on Figs. 7 and 8 the amount of steam to be generated is found to be:

	Lbs. per Year
For *a.*	12,500,000
b.	6,800,000
c.	5,800,000
	25,100,000

To evaporate this quantity of steam 2,620,000 lb. of coal will be required, costing $6,222.

From the curves on Figs. 7 and 8 the diesel set will run as follows:

	Kw.-Hr.
a. Daylight Dec. to March	218,000
b. Daylight Oct., Nov., April and May	281,000
c. Daylight June to Oct.	312,000
d. Nights all the year	246,000
e. Sundays all the year	62,500
	1,119,500

Diesel fuel oil at 6c. per gallon will cost approximately $6,000 per year.

Investment costs:

Two 100 sq.ft. boilers	$5,000
Feed pumps and feed water heater	1,000
Blowers and stokers	3,000
Breeching	750
Foundations	500
One 200-kw. uniflow engine set	16,000
Foundations	2,000
Piping	3,000
One 250-kw. diesel engine set	19,000
Foundations	3,000
Erection	1 000
Diesel water cooling equipment	1,000
Diesel engine auxiliary	1,000
Diesel fuel tanks, pumps, etc	2,000
Switchboard, electrical connections, etc	3,000
	$61,250

Operating costs:

	Per Year
Interest, depreciation, etc., 13 per cent	$7,950
Labor	11,400
Coal	6,280
Diesel fuel oil	6,000
Lubricating oil	600
Ash removal	200
	$32,430

	Per Year
Cost of purchased steam and electricity	$57,000
Operating costs, boiler plant with steam and diesel sets	32,430
Saving	$24,570

D—LOW-PRESSURE HEATING WITH DIESEL-ELECTRIC SETS

For this condition, the following have been assumed:

1. Two—1,000-sq.ft. boilers with hand-fired grates.
2. Diesel-electric sets, 1 250-kw. and 1 200-kw.
3. Anthracite coal, buckwheat, 10,000 B.t.u., $4.50 per 2,240 lb.
4. Boiler efficiency, 68 per cent.
5. Boiler feed temperature, 197 deg. or 165 B.t.u. above 32 deg.
6. Heat in the steam, 1,153 B.t.u.

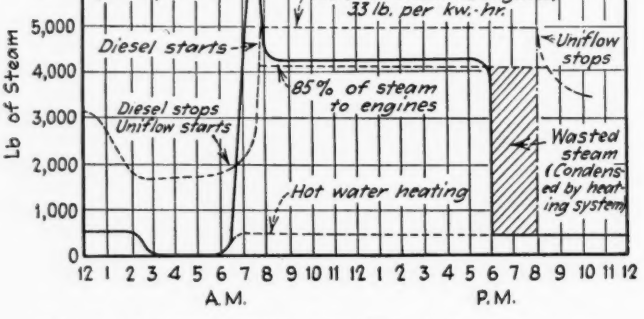


Fig. 8—Minimum heating conditions (Oct., Nov., April, May), boiler plant with both steam and diesel engines

The amount of steam required for heating and hot water is, as figured out previously, 16,870,000 lb. per year. To evaporate this quantity of steam, 2,450,000 lb. of coal will be used, costing $4,900.

The electric power (from Fig. 3) is 1,672,000 kilowatt-hours.

The diesel fuel oil for 1,672,000 kw.-hr. at 5c. per gallon will cost $7,600 per year.

Investment costs:

Two 1,000-sq.ft. boilers	$5,000
Breeching	750
Foundations	500
One 250-kw. diesel engine set	19,000
One 200 kw. diesel engine set	15,000
Foundations	5,000
Erection	1,500
Diesel water cooling equipment	1,500
Diesel engine auxiliary	1,000
Diesel fuel tanks, pumps, etc	2,000
Piping	1,000
Switchboard and electrical connections	3,000
	$55,250

Yearly operating costs:

Interest, depreciation, etc., 13 per cent	$7,200
Labor	12,700
Coal	4,900
Diesel fuel oil	9,120
Lubricating oil	800
Ash removal	440
	$35,160

Cost of purchased steam and electricity	$57,000
Operating costs of low pressure heating and diesel electric sets	35,160
Saving	$21,840

Summarizing the savings of the various schemes outlined:

A.....$ 3,500 per annum
B..... 19,850 per annum
C..... 24,570 per annum
D..... 21,840 per annum

In the foregoing considerations it will be noted that no account has been taken of the space or cost of a stack, because most buildings of this size would have one incorporated in the construction as a precaution anyway.

Also, no breakdown service has been accounted for, because as figured above, there would always be available one machine large enough to run the elevators and corridor lights during an emergency. However, if a breakdown service is considered necessary, a connection for a nominal 100 kw. would be sufficient, as 150 to 200 kw. could be drawn from it if required.

Breakdown service for 100 kw. would cost $2,400 per year, but this would not be all lost, because a quantity of electricity equal to $2,400 may be used at any time during the year without extra charge, and this would reduce the running time of the engines.

Instead of working out a building for one of an unlimited number of special cases, the writer thought it better to work out a typical building and apply the special conditions to it in the following manner.

Taking Scheme C, which shows an annual saving of $24,570 for an outlay of $61,250, and assuming that the investor would be satisfied to pay for the equipment in five years, $12,250 of the saving would have to be considered as paying for the installation, and $12,320 per year could be lost in rental space occupied and additional investments in foundations or building changes, before the individual plant would cease to be attractive.

In conclusion the writer would like to say that he expects to be accused of being too partial to the individual plant, but he has tried to be impartial and have the figures speak for themselves. If there are any criticisms he will heartiliy welcome them.

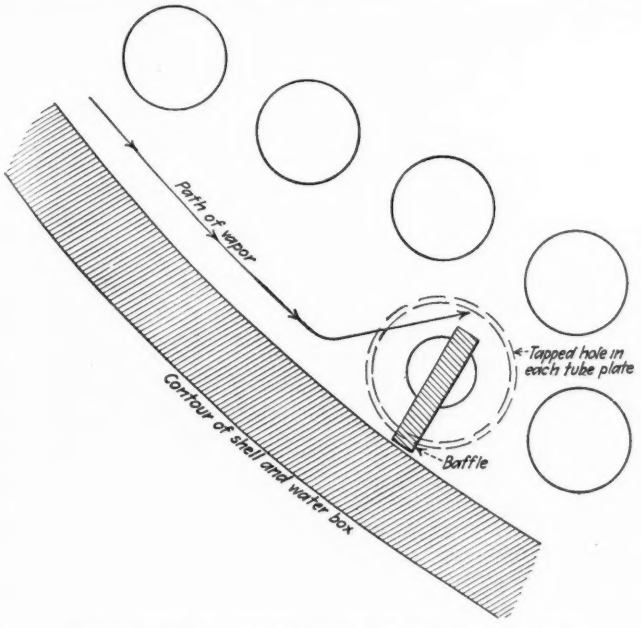
Baffle Prevents Bypassing Condenser Air Cooler

By ERNST HOLT

London, England

I HAD to investigate a case of low vacuum on a 3,000-kw. steam turbine set and found that uncondensed vapor was bypassing the aircooler portion of the condenser. As a result the capacity of the air ejector was reduced and the vacuum obtained was lower than the guarantee figure.

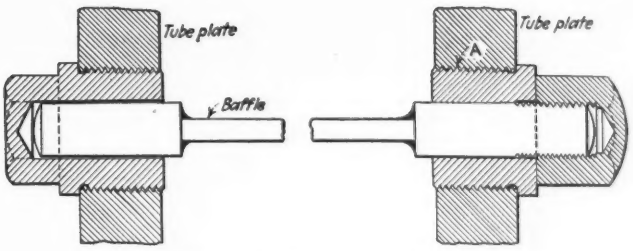
Since this occurred, I have observed several condensers that suffered from this defect in a greater or lesser degree. The cause may be carlessness in the tube plate layout or discrepancies when marking out the tube plate for drilling. The outside tubes of the air cooler should be pitched as closely as possible to the shell. Some manufacturers fit a rib the whole length of the condenser shell, which diverts the air and gases into the tube nest. This is good practice. If this has not been done, and if, on inspection of the layout of the tubes, it is thought that condensible vapor is reaching the air



Baffle should be located so that it comes as close to the shell as possible

offtake, a cheap and efficient repair may be carried out in the following manner.

A piece of flat bar, say 1x¼-in., should be procured, the length of which should be about 1 in. less than the dimension between the condenser tube plates. This is to serve as a baffle. To each end of the bar a ½-in. stud should be welded, one plain and the other screwed. Choose the most suitable position and drill and tap a hole, in relative locations, in each tube plate. The hole should be large enough to take the baffle, which is shown in the figure. The studs must be so welded to the bar that when the bar butts onto the shell the studs are concentric with the tapped holes in the tube plates. The screwed stud should be a rather tight fit in its nut, so that when the assembly is made the baffle will not swing



Studs to which the baffle is welded are held in the tube sheets as shown

out of position due to vibration. The plain stud can be held in a wrench, with the baffle in correct location, while the nut at the other end is tightened. The ferrule *A* may be screwed home by forming a slight square in its bore, or by lightly tapping with hammer and chisel. A slot must not be cut in the face of the ferrule, or the pressure and vacuum spaces will be put into communication through the clearance in the ferrule. If the threads in the tube plate and on the stud are made the same pitch, the ferrule and nut may be made in one piece.

It is recommended that brass or galvanized iron be used for the baffle, otherwise extensive corrosion will occur.

The repair can be accomplished during the time the condenser is opened for routine tube cleaning, and the result will be either improved vacuum or reduced power consumption of the air-removal equipment.

▼

Making Noisy Motors Operate Quietly

NOISY OPERATION of induction motors may be attributed to three causes: namely, magnetic faults; mechanical and electrical unbalance; and windage. Magnetic faults are largely a matter of design. The noise appears as a highly-pitched hum and is likely to be more pronounced in a 60-cycle motor than in a 25-cycle machine. This fault is frequently caused by loose laminations in the stator or rotor cores.

The magnetic flux, being alternating in character, pulls the laminations together as it builds up to a maximum and releases them as it decreases to zero. Unless the laminations are held tightly they will be caused to vibrate by the compressing and releasing action of the magnetic flux. When magnetic noises are produced by this cause it is frequently possible to alleviate them to a considerable degree by tightening up on the holding bolts or other devices used to retain the laminations in place. Another cause of excessive magnetic noise is overvoltage, the remedy for which is obvious.

The ratio between the number of slots in the stator and rotor cores affects the noise produced by an induction motor, as does the pitch of the coils in the winding. Using skew slots in the rotor core will help to reduce the noise. Modern induction motors can be had that are fairly quiet in their operation.

Current and mechanical unbalance, the second cause of noise, may be due to several causes. Poor connections on some of the rotor bars will cause an electrical unbalance that will produce noise and vibration. Several grounds in the rotor windings of a wound-rotor motor

have been known to cause severe vibration of the machine and noisy operation. Worn bearings, allowing the rotor to get out of the center of the stator bore, may have a similar effect. Considerable unbalance of the line voltage is likely to cause sufficient current unbalance in the windings to produce vibration.

Noises due to unbalance of the electric circuit in the motor usually vary with the load, being highest with heavy loads. The remedy for these faults is to search out the causes and make the necessary corrections. This is done by a systematic series of tests, such as checking the voltage and current of each phase when the motor is in normal operation; testing the windings for grounds, short circuits and open circuits.

On many motors the pole-phase groups of the windings are connected in two or more parallels. In such windings it is possible for one of the parallel circuits to be open without seriously affecting the motor's operation, except it may be a little more noisy than normal. This fault would show up, however, if current readings were taken in each phase. The phase with the open section of winding would give a low reading. Other checks on the motor are for loose rotor bars and for an unequal air gap around the rotor.

Windage noises are due to projecting parts of the rotor. Deep rotor bars may be a serious offender in this respect. If slots are left open in the core they may increase the windage noise. This noise may be distinguished from most of the others in that it will continue after the motor has been disconnected from the source of power. When the motor has been disconnected from the line the noises due to magnetic and unbalanced current causes will cease, but those produced by windage or mechanical unbalance will continue until the motor has slowed down.

▼

Changes in Operation That Reduced Costs

By IRA A. BUTCHER

IN MANY power plants and industrial processes there are large opportunities for reducing cost by improved practices. These improvements take on an almost unlimited number of forms, depending upon the type of plant and the combination of power and process requirements. All cost reductions are not made by improving power and process operations. Frequently a change of equipment may result in large savings in maintenance costs and increased production. The following will indicate some plant and equipment improvements that have been made and the results obtained:

The maintenance costs of a number of oil-fired furnaces for cooking oils were excessively high due to the rapid burning out of the refractories. Furnace temperatures were also causing the disintegration of the concrete floor supporting the furnaces, permitting the leaking of oil into the room below and causing a fire hazard. By enlarging the furnace, reducing the heat release per cubic foot of furnace volume and providing proper insulation, these troubles were cured and the time required to cook a batch of oil was reduced 20 per cent. The fumes from the cooking kettles were carried to boiler furnaces, but were introduced at the wrong location. The result was that a large percentage of the fuel burned in these furnaces was wasted. If the fumes had been introduced at the proper location they would have had no effect on the furnace's operation.

In another plant the installation of a feed-water heater and proper attention to leaks and firing methods cut the fuel bill almost in half and provided an abundance of steam where there had been a shortage.

A survey in another plant revealed hot-water going into the sewer and cold water going into the boilers, although both were led into a common tank that was supposed to supply the boilers with the hot water, with the cold making up the deficiency.

A building heating plant after being installed would not function properly. It was found that the boiler had been assembled so that the furnace gases were short circuited, making only one pass through the boiler where they should have made two. The mains were pitched the wrong way in a number of cases, so that the circulation was faulty, and about half of the thermostatic traps had never been installed at the unit heaters. These conditions were corrected and the plant operated satisfactorily.

Semi-annual replacement, due to breakage, of a large gear was eliminated by the installation of another type of gearing which cost less than $900, while the annual cost of the old gearing was over $1,000.

There was no magic in finding and correcting these faults or conditions. They were revealed by a careful analysis of the plant conditions and by the application of engineering skill and experience to the corrections.

The following are some of the obstructions that I have removed from the road to profits. In most cases the companies did not realize that the faults existed, or if their presence were recognized it was generally supposed that their removal would be too expensive.

One large corporation had extended its plant from time to time under the direction of its engineering department. A survey of its electric transmission lines, on which production was being curtailed because of lack of power, revealed that the motors near the end of the line were receiving current at only about half the proper voltage. The excess line losses alone amounted to over $10,000 a year. It cost less than $200 to correct the trouble.

A plant using a great deal of hot water had reached the point where it was necessary to maintain a pressure of from 150 to 175 lb. at the pumps in order to supply the various departments. A check-up revealed that by the replacement of a few pieces of badly scaled pipe, and some minor additions, an adequate supply was available with pressure not exceeding 50 lb. at the pumps. In addition to the power savings there was also a considerable saving in maintenance on the pumps, as they were not built for the higher pressure.

A company having a great deal of power plant trouble found that by proper attention to boiler settings, combustion chambers, insulation, leaks and by providing proper operating instructions the troubles largely disappeared and their fuel bill was reduced over $40,000 per year.

The management of a plant having five boilers was about to install another because of almost daily shutdowns due to lack of steam. A survey resulted in correction of operation practices and conditions which made the boilers more than adequate for the job. The payroll loss alone, due to the shutdowns, was $4.50 per minute.

PRACTICAL AIDS TO OPERATION

Broken Piston Rod Causes Knock

IN OVERHAULING one of our two-stroke cycle crosshead-type Diesels the No. 2 piston came out of the cylinder minus the piston rod. This quickly indentified a knock we had experienced in this unit for some time. The knock would occur during the last three revolutions of the shaft when the engine was being shut down. The engine ran as quietly when under load as it did when installed.

In our efforts to find the cause of this knock we had checked all the bearings and crossheads and found them in proper adjustment. We had also pulled the pistons, thinking that a piston might be sticking at low speed and causing a bearing to pound when adjusted to the proper clearance.

That this rod had been broken for some time was indicated by the condition of the parted ends of the rod. The rod is tapered and fits into a plate that bolts to the piston. The break occurred in the taper. The fit of the rod in the plate was so close that the piston stuck onto the rod as the engine came to rest and the rod was lifted out of the cylinder with the piston when it was pulled the first time we looked for the knock. Of course this pounding soon caused wear, so that on pulling the piston this time the rod did not stick in the plate.

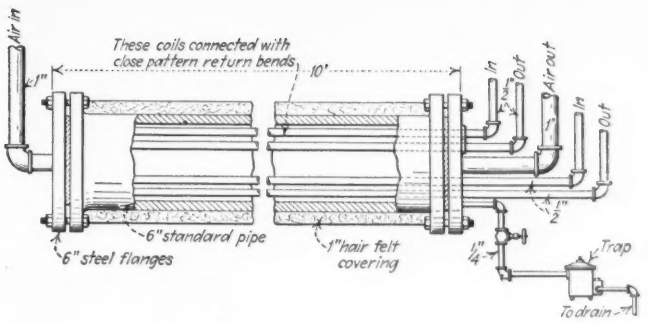
The reason for the breakage was evident on comparing the broken rod with the replacement rod ordered from the factory. The new rod has a very little taper and has only one large passage through the center of the rod instead of two for the cooling oil to flow to the piston and return. This single passage is divided by a $\frac{3}{4}$-in. pipe in its center for the oil to flow to the piston and return through the space around the pipe.

Waltkill, Neb. WM. W. DINGWALL.

Removing Moisture From Air Lines

WHILE VISITING the new Los Angeles Stock Exchange Building recently, Elgin B. O'Dea, the engineer, told the writer that shortly after this building was occupied it was noticed that the high pressure air system was becoming filled with water. This, in turn, caused the woodwork to be damaged when air was used for blowing tubes of the Lamson tube system, which unavoidably became stopped up from time to time. After some negotiations it was decided to build an experimental moisture remover according to the attached diagram.

Ten feet of 6-in. pipe was purchased with flanges and blind flanges, thus making it a receiver. Inside of this receiver were placed two coils of 100 ft. each of $\frac{1}{2}$-in. galvanized iron pipe connected with parallel. The compressed air was admitted to the receiver through a 1-in. opening tapped with the end of a 6-in. blind flange flowing parallel to the coil and taken out of the other blind flange, thence to the air receiver. The water from the cooling coil was tapped from the air-washer pumps connected with the air-conditioning system, the average water temperature being 55 deg. F.



Section through moisture removes

Upon completion of this aftercooler it was possible to take air into the compressor at a temperature of 77 deg. dry-bulb and 60 deg. wet-bulb, compressing it up to 70 lb. pressure, delivering it to the receivers and then distributing it through the pipe line out into the buildng with no moisture present in any part of the system. Since the installation has been made there have been no traces of water in the receivers. This aftercooler was designed to handle $12\frac{1}{2}$ cu.ft. of air per minute; and thus far has proved satisfactory. LAURALINE MACK.

Hollywood, Calif.

Look Out for Oily Vapor

THE REVOLVING FIELD generator windings in a plant that came under the writer's observation were continually soaked with oil, and as the plant was more or less exposed to a dust-laden atmosphere, these windings soon became a sorry mess, and nothing short of blowing out with gasoline would clean them.

The bearings were checked for oil leakage, but it was found that the oil was not getting to the windings from this source and it finally became a problem to find just where the oil was coming from.

These generators were belt-driven from horizontal, enclosed-crank-case gas engines and the vents from the crank cases were open and free to the air within the power plant. Nothing was thought to be wrong with this practice, but there seemed to be a sort of hazy atmosphere in this plant that showed up when the sun shine came in at just the right angle and by watching the crank-case vents against the sunlight, it was easy to see vapor coming out into the power house.

It was finally discovered that these vents were pouring enough oily vapor into the atmosphere to saturate it to a point that the oil would condense out in the generators and collect in the windings.

In explanation of this, it may be better understood by saying that the revolving fields of the generators carried fans, that drew in air from the atmosphere and blew it through the stator windings at high velocity and carried away the heat from the coils. These fans were drawing the vapor-laden air in and discharging it at such high velocity that it was cooled enough to condense

the oil back to a liquid and it clung to the surface of the coils.

After this discovery, it became evident that the vapor from the crank-case vents would have to be kept from escaping into the air within the power house, or that it would have to be separated out by some means.

A small separator working on the principle of the cyclone dust collector was made and tried out on one of the vents, but the velocity of the escaping vapor was not high enough to separate the oil out.

Running vent pipes from each engine to the outside of the power house was now considered, but some one suggested that the vents from each individual engine be piped into its own air intake. There were four small vents on each engine and they were accordingly connected to a common pipe and this pipe led into the space under the engine frame, from whence the engine took its air.

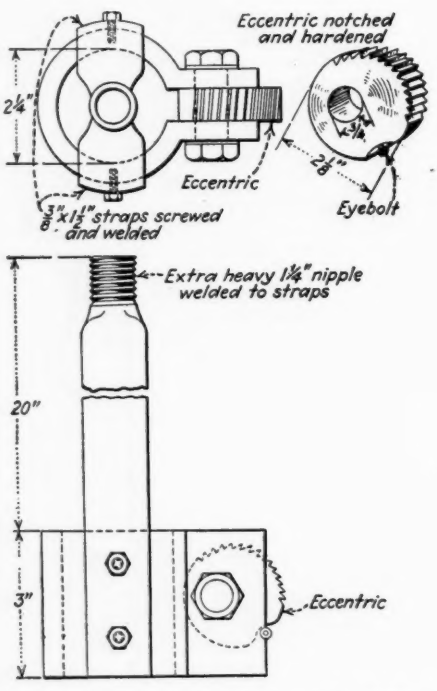
This placed a slight vacuum on the vent pipe at each suction stroke of the pistons and instead of the vapor accumulating on the generator windings, it was drawn from the crank case and entered the cylinders with the gas and air mixture to either assist in lubricating the cylinders or to enrich the gas-air mixture, or possibly a little of both. EARL PAGETT.

Coffeyville, Kan.

Plunger and Broken Rod Fished Out of Deep Well

WE RECENTLY had the misfortune to break a coupling on the inside rod that supports the lower plunger of our power-driven deepwell pump, and the plunger went to the bottom of the working barrel, 99 ft. from the surface.

This plunger is 9.75 in., and the coupling broke at a point 20 ft. above, so we had to fish them out by grabbing the end of the 2-in. rod with enough grip to lift the 20 ft. of rod and the plunger, as well as the weight of the water.



Grappling tool made to remove broken plunger rod from well

After two well drillers failed to lift them, I had a tool made as follows:

The opening is of 2.25 in. diameter and the clamp is 3 in. long, with a strap screwed and welded to each side and the two upper ends welded to a nipple of $1\frac{1}{4}$-in. extra-heavy pipe, so we could use pipe of that size for our pull rod. The eccentric is a little over 2 in. in diameter, with a 0.75-in. bolt to resist shearing. The face is notched and case-hardened. In the side we cut out a notch and then drilled and inserted a small eye-bolt so the eccentric could be rolled over to take hold.

Before lowering in the well, we fastened a funnel of 18-gage sheet metal to the clamp so it would easily center on the rod when we reached it, and on the first attempt we clamped the rod and lifted out.

This may be "old stuff" to some, but it was a novel experience for us. F. R. SWINK.

South Bend, Ind.

Regulator Fails to Function Because of Wrong Connections

THE automatic voltage regulator on the generators in our plant failed to function properly because of a burned-out resistor. The resistor was replaced by a new one obtained from the manufacturers, but the regulator would not operate. The electricians tested the resistor, checked all connections, cleaned contacts and reset the relays, to no avail. They came to the conclusion that the main control coil had gone bad, and as there were no more coils on hand and as the machine was large enough to carry the load required at that time the regulator was not used.

Later, due to increased load, the regulator was required. The electricians wanted a new coil, but the cost was high, and I was not satisfied with the tests made on the regulator. I found that current would pass through the supposedly bad coil. Tests made for short circuits and grounds showed the coil to be all right. A set of diagrams and descriptive literature was secured from the maker. With the aid of these the external resistors were tested from the board, and one resistor measured 20,000 ohms when it should have been 118 ohms. This resistor was taken off the board and tested again, only to find it in good condition. It was found that the test was made across the wrong set of contacts and accounted for the high resistance previously obtained.

As a last resort it was decided to check all connections even though they had been gone over several times by other electricians. I went over all the wires and found two were wrongly connected. After the necessary changes had been made the regulator was put into operation and it worked perfectly.

The generator whose voltage the automatic regulator controls is a 350-kva. machine which is usually run in parallel with a 150-kva unit. To give the regulator a real test we dropped the voltage on the small machine so that the exchange of current between the two generators was beyond the meter readings, but the regulator held the voltage within 10 per cent of normal voltage. This is another illustration that persistence pays.

Lowell, Mass. CLARENCE W. HOPE.

CURRENT COMMENT

Cutting Out Coils in Winding Caused Motor to Vibrate

When a coil fails in a three-phase induction motor it can readily be cut out and the winding closed, as asked about by E.H.C. in the March 1 number. There is generally no necessity of cutting out coils in the other phases. The pole in which a coil is cut out will be slightly weaker and might in some cases cause vibration, but this tendency should be small in most motors. The writer knows of one case where, on a four-pole machine with one coil cut out, the motor could not be run due to the heavy vibration. Cutting out one coil in each of the other poles enabled this motor to be run until permanent repairs could be made.

When a motor winding is connected with two or more circuits in parallel per phase it may be necessary to cut out more than one coil, that is, if there are more coils in one phase circuit than in another, a circulating current may be set up which would overheat the motor. This is only where the winding sections are connected in parallel, and it is then often necessary to cut out a coil in all good circuits of the same phase in which the defective coil is located.

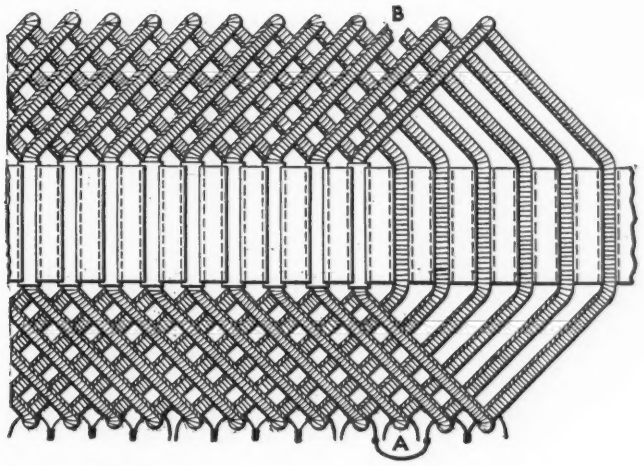
The number of coils which may be cut out without affecting a motor's operation depends on the load and the number of turns per coil. Of course, more coils may be cut out on a lightly loaded motor than in one that is working to its full capacity. Also, more coils can be cut out in a motor which has many coils in series per phase with comparatively few turns per coil than in one of which the opposite is true. In general approximately 10 per cent of the coils in any phase can usually be cut out without seriously disturbing a motor's operation although the exact amount is determined by the design of the motor and the percentage of full-load being carried.

F. Fraser MacWilliams.

Johnstown, Pa.

It is common practice to cut out a damaged coil in an induction motor in order that the equipment may be kept running until a permanent repair can be made. The process to follow is to disconnect both ends of the damaged coil and connect the remaining part of the winding together as at *A* in the figure. Using a sharp chisel, cut all the turns of the damaged coil as shown at *B*. This is to prevent the coil from heating in case it is short circuited.

The number of coils that may be cut out of a motor depends on a number of factors. One coil may be cut out of the winding of any of the more recently designed motors. At one large industrial plant having 1,400 motors in operation it was necessary to make a ruling regarding this point and it was finally decided that 30 per cent of the winding of any phase was the maximum



Section of winding showing how to cut out a coil

to be cut out of any motor. This decision was made because after 30 per cent or more was removed from a winding the probability of the motor lasting out the shift was small. Therefore, when more than 30 per cent of the winding was damaged a new motor was installed.

Cutting out of a coil should never be considered a permanent repair. Removing a coil affects the efficiency and operation of the motor, depending upon the design. It lowers the reliability factor and this is important where production continuity must be maintained.

Great Falls, Mont. B. W. Hamilton.

Although I have seen it advocated in a number of books on the subject, I have never resorted to the method of balancing the winding by cutting out an equal number of coils in all phases when removing a defective coil from an induction motor winding. In extraordinary cases this might be necessary, but I have not found it so when dealing with a large number of patch jobs.

The number of coils in a particular winding circuit determines the number that may be cut out without apparent effect on the motor's operation. It is generally possible to cut out most any reasonable number of coils from large high-voltage motors. As examples, I have cut out nine coils from a 108-coil stator of a synchronous motor, operating on 2,200 volts, and connected series-star. Seven coils were successfully removed from an 144-coil stator with a series-delta connection, operating on 2,200 volts. This motor was of the slip-ring type used to drive a mine hoist. I cut out three coils from an induction-motor stator with 72 coils, connected series-star and used on 2,200 volts. This motor was used to drive a centrifugal pump inside a mine.

It is not necessary to make an extensive survey of connections when removing coils. Be sure to find the coil which is grounded or short circuited and remove only this coil from circuit. I nearly always cut the coil entirely in two to prevent future trouble from it.

Out of a large number of repairs made on all sizes and voltages of motors and a large number of different connections I remember only three failures due to cutting out coils. One was a 75-hp. slip-ring semi-closed slot motor operating on 220 volts; another 4-pole 1,800-r.p.m. 220-volt induction motor; and a 1-hp. 220-volt motor with only a few coils. After a coil was cut another failed and after two or three trials it was decided that a rewind would be necessary.

Birmingham, Ala. Grady H. Emerson.

READERS' PROBLEMS

STEAM ENGINES APPEAR TO CAUSE VOLTAGE FLUCTUATIONS — *In our power-generating station there are three units: a 750- and a 625-kva. generator, each driven by a steam engine; a third generator of 219-kva. capacity driven by a diesel engine. All three units may be connected to the same busbars and are equipped with automatic voltage regulators. Out on the distribution system there is a motor-generator set consisting of a 150-hp. synchronous motor driving a 100-kw. direct-current generator. A voltmeter connected anywhere on the system shows a voltage fluctuation of about 2 volts, but this does not affect the light on the system. When the diesel engine unit is supplying the power alone the voltage fluctuations do not occur. These fluctuations are also absent when the motor-generator is shut down and the steam engines are supplying the power. It has been suggested that the cause of the trouble is the synchronous motor and that a change should be made to an induction motor. What might be the cause of the trouble and how can it be remedied?* J.D.E.

If the voltage fluctuations do not affect the lights, why bother trying to prevent them. Two volts fluctuation is in general not considered objectionable, in so far as lighting service is concerned, and this is usually the chief cause of complaint against voltage variations.

Because taking the synchronous motor off the system eliminated the voltage fluctuations is no reason to believe that the source of the trouble is in the motor. The cause may be in the steam engines that has a slight variation in angular velocity, which, in turn, causes a frequency variation that produces a change in the angular velocity of the motor. The motor, attempting to follow the variations in frequency, would magnify the conditions produced by the engine, and cause the voltage fluctuation to which you refer.

Replacing the synchronous motor with one of the induction type would correct the trouble. If space will permit, increasing the flywheel effects of the rotor of the synchronous motor should help correct the trouble, and would probably cost considerably less than changing the motor. Increasing the weight of the flywheel on the engines will also reduce the voltage fluctuations.

If for any reason the voltage fluctuations are objectionable, and must be corrected, it would be advisable to take the matter up with the manufacturers of synchronous motors and see what they have to recommend. The manufacturers are familiar with the characteristics of the motor, and are in a better position to advise you than any one else.

Although not noted in the question, it may be that the voltage fluctuations are reflected through the motor-generator into the direct-current system. If this is so, a properly designed reactor in that circuit should correct the trouble. This is something that should be taken up with the electrical manufacturers, so that a reactor of proper design may be obtained. If you happen to have a good-sized transformer around the plant, you may connect the two sections of the low-voltage winding in parallel and connect these in series in the direct-current circuit as a reactor to determine what effects this will have in smoothing out the ripples on the direct-current voltage, if there are any.

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STEAM THROTTLED WITHOUT CHANGE IN QUALITY—*If dry, saturated steam at 1,000 lb. gage pressure is reduced to 100 lb. gage by passing through a reducing or throttling valve, what will be the final quality?* T.E.M.

The answer to this question may surprise even those engineers who are fairly familiar with steam-table data. For the pressures specified there will be no change in quality; that is, the throttled steam will be dry, saturated.

As the pressure goes up the total heat of dry, saturated steam increases up to 430 lb. abs., where it is 1,204.1 B.t.u. per pound. Going either up or down from this pressure the total heat of dry, saturated steam decreases.

In throttling there can be no change in total heat. It therefore follows that if we throttle dry saturated steam at a pressure not higher than 430 lb. to a lower pressure it must pick up superheat to maintain the heat balance.

It also follows that if dry, saturated steam is throttled in any high-pressure range, so that the lower pressure is still above 430 lb. abs., the steam must become wet.

Thirdly, if dry saturated steam above 430 lb. abs. is throttled to a pressure below 430 lb. abs. the two effects partly cancel, and if the pressures are properly selected they will completely cancel.

This applies in the case under consideration. The total heat in dry saturated steam at 1,015 lb. abs. is 1,189 B.t.u. per pound. At 115 lb. abs. it is also 1,189 B.t.u. Hence no change in quality can occur.

The accompanying table gives some other combinations where the result is the same.

INITIAL AND FINAL TEMPERATURES FOR WHICH QUALITY DOES NOT CHANGE

Pressures, Lb. Abs. Initial	Pressures, Lb. Abs. Final
1,000	118
900	148
800	185
700	232
600	290
500	360

▼ ▼ ▼

Oil Specifications Offer Cure For Diesel Trouble

Majority of readers' answers to previous question stress importance of suitable analysis and properties

WE HAVE RECEIVED a car of diesel fuel oil, but find that it will not burn in our solid-injection engines, although it meets specifications that have resulted in suitable oil up to this time. What could be the cause of this difficulty? The oil comes from an Atlantic Coast refinery. E.T.S.

—❖—

Watch Viscosity and Timing

IN THE ABSENCE of the specifications on which E.T.S. orders his fuel oil it is hard to say what is the cause of the oil not burning in solid-injection engines.

At one time, when we did not specify the viscosity of the fuel we ordered, we seldom found that we could start using oil from a new car without trouble with our highest-speed engine. This was not noticed on the slower-speed engines unless there was quite a difference in the viscosity of the oil. We now make a practice of specifying viscosity on each order.

After we change from one car of fuel to another we let the engines run about two days and then check the timing with a diesel-engine indicator, to see that the combustion is not lagging.

If no indicator is at hand watch your exhaust pyrometer. It will show high temperatures due to the unburned fuel burning in the manifold. Of course you would expect to see black smoke from the exhaust stack, but this will not al-

ways be discharged due to the complete combustion of the fuel in the manifold of the engine.

Some fuel systems are not designed for oils of high viscosity and will not atomize the fuel, so that it will all burn in the higher-speed engines. In a case of this kind the only thing to do is to reduce the viscosity by heating the oil or mixing it with a lighter oil.

Another trick that will help is to raise the compression about 25 lb. I would not raise it any more as it may be too great a strain on the engine. It will also help if the cooling water discharge temperature is raised. This will allow more heat to remain in the cylinder to help vaporize the oil.

If E.T.S. will make sure that injection begins at the right time and experiment a little along the line shown above I do not think that he will have any trouble making his engine burn this car of fuel. He should also remember to specify the viscosity of the oil he can use in these engines. The builder will be glad to furnish the information.

WM. W. DINGWALL.

Walthill, Neb.

Perhaps It's the Engine

THE EXPERIENCE mentioned by E.T.S. is similar to that which occurred some years ago in a large plant which contracted for its fuel three years ahead. Suddenly the engines failed to deliver full load and would almost stall from a rapid swing. On indicating them it was seen that the combustion was late with much afterburning.

As nothing mechanically wrong could be found, the fuel cam was advanced 5 deg. and different fuel nozzles were installed. This gave a normal indicator card, and the engines would develop full load but were sluggish on swings. After about two weeks, the indicator showed that all compressions had increased about 50 lb.

A cylinder was opened up, and it was found that a deposit about $\frac{1}{8}$ in. thick had formed all over the combustion chamber. This had a hard glaze about $\frac{1}{64}$ in. thick and similar to that on glazed earthenware. The remaining deposit was of an earthy nature.

Nothing wrong could be found with the filters or screens, nor was there any evidence of scoring of the fuel pump or needle valves. Raising the compression 60 lb. got rid of this formation. Up to date the reason for this foreign matter has not been discovered, or, at least has not been made public.

After burning several carloads of oil, with strong protests to the refinery, the engines suddenly picked up. The indicator then showed early ignition, high maximum pressures of 650 lb., and was readjusted to its original setting.

On several other occasions new or different fuel was blamed, but investigation showed that the engines were at fault due to one or more of the following causes:

1. Fuel pump, check or spill valves leaking or not functioning properly due to faulty springs or shoulders being formed on the valve seats.
2. Compression too low.
3. Compression correct, but temperature of inlet air too low.
4. Fuel nozzle in imperfect condition.

Globe, Ariz. J. J. MCDOUGALL.

Study the Composition

THE DIFFICULTY with the diesel fuel in question is undoubtedly one of chemical rather than physical properties. While this fuel may meet the specifications commonly used—such as gravity, flash, viscosity, pour, sulphur, and sediment—the chemical structure and properties may vary considerably.

Some fuels are unstable and very active chemically, oxidize rapidly, and are very free burning. Paraffine-base oils, rich in saturated hydrocarbons and with a high hydrogen content, burn or oxidize readily. Usually the higher the hydrogen content the more readily the fuel burns, the lower the hydrogen content the slower the combustion.

Other fuels of the same approximate physical properties are stable and very inactive chemically, extremely slow burning, and are burned with difficulty. This is characteristic of some asphaltic oils and certain of the naphthenic series of hydrocarbons, which are found in Gulf Coast and Texas Crudes. Fuels of this class usually give very smoky exhaust, incomplete combustion (even at fractional loads) and form an excessive amount of carbon.

This difference in chemical structure may be due to the origin of the Crude, and partly, at least, to the method of refining. W. K. GREGORY.

Oak Park, Ill.

A Question for Our Readers

WE HAVE recently supplanted coal fuel with natural gas under our two Stirling-type boilers of 2,600 and 1,500 sq.ft., respectively. The boilers are connected with a steel smoke stack designed for coal use. The stack has become very unsightly on account of the large amount of condensation from the hydrogen in the gas fuel. The stack has a diameter of 54 in., is 140 ft. above the floor, 125 ft. above damper. One half is made of $\frac{3}{8}$-in. steel, the other half of No. 8. Our maximum rating on the larger boiler, which we use most of the time, is 130 per cent. The gas temperature at this rating is 412 deg. F., draft 0.07 in. of water. What is a reasonably inexpensive method of saving the stack from deterioration? C.O.

Suitable answers from readers, if received promptly, will be paid for when published.

Specify Oil Properties

IT IS IMPOSSIBLE to judge from the question of E.T.S. just what difficulty he is having with his diesel engines. However, the things to specify in purchasing fuel oil are:

B.t.u. Value—The usual figure is 18,500 B.t.u. per pound.

Carbon Residue—About 1 per cent of carbon residue by the Conradson Method.

Water—About 1 per cent of water is permissible.

Viscosity—About 150 sec. Saybolt Universal at 70 deg. F. should be maximum.

Sulphur—Sulphur should not exceed 3 per cent.

Flash Point — Usually specified by Underwriters at 150 deg. F., closed cup.

In addition to the above the fuel oil should be free from grit and mineral acids.

Some vacuum distillate products have a tendency to foam and vapor bind the fuel pump. I have never seen specifications which would distinguish this property in fuel oil, but it is one which must be watched. JOSEPH HUBER.

Malvern, Ark.

May Be "Cracking" Residual

PRACTICALLY all of the crudes supplied to Atlantic coast refiners are very low in gasoline content. In order to increase the gasoline recovery, high-pressure distillation (or cracking) is resorted to. The residual fuel oils obtained from such a process have the same general characteristics as fuel oils from low-pressure distillation. However, the hydrocarbon structure is altogether different and this has a large influence on the burning qualities of the fuel.

It is very probable that the shipment of fuel oil referred to in the question, is of such origin. Or, more probably, it is a mixture of cracking process residual fuel and gas oil.

However, it is a very broad statement to say that it will not burn in E.T.S.[1] solid-injection engines. I would call to his attention that there are engines operating very satisfactorily on fuel oils with a range of coal tar to kerosene. I am sure that a close study of indicator diagrams taken from the engine would also show, that with some changes in fuel valve settings, compression, etc., the engine would operate on the so-called bad fuel very satisfactorily.

H. W. STALNAKER.

Osceola, Ia.

Pressure-Furnace Boiler Is Revolutionary Development

Brown Boveri develops the Velox boiler, whose furnace operates under several atmospheres' pressure. May operate on explosion cycle or constant-pressure cycle. Is planned for use with steam and gas turbine installations. Plant outputs of 30 kw. to 40 kw. per cubic foot of furnace space are claimed

A BOILER development announced in the January number of the Brown Boveri *Review* (Baden, Switzerland) is a radical departure from current practice. Renewed study of gas turbine problems led indirectly to the development of a steam generator with a pressure-charged combustion chamber.

Operation may be on a constant-pressure cycle or on an explosion cycle. The immediately projected application is to plants combining steam and gas turbine for the greatest over-all efficiency.

The following account, with illustrations is taken from the *Review:*

The work with the gas turbine, the development of which we took up again in 1928 with Holzwarth, has now passed the stage of preliminary tests, so that it is already some time since we were able, after many modifications, to commence the construction of an actual plant, the completion of which is to be expected shortly. Our activities with the gas turbine problem (it must be admitted that this is really a very difficult problem), have, besides leading to the above mentioned construction, opened up a number of new paths, from which finally the Brown Boveri Velox boiler, a steam generator with pressure charged combustion chamber, has been evolved.

Corresponds to Supercharging of Internal Combustion Engine

For example, it has always been considered, for the design of steam boilers, the natural thing to supply the combustion chamber under atmospheric pressure and to take in the combustion air and set it in motion by the natural draft of a chimney, which is perhaps slightly raised by means of a fan; this corresponds exactly to the charging of an internal-combustion engine merely by the suction effect of the piston.

In the case of internal-combustion engines, we have been able, by "pressure charging" by means of a compressor driven by an exhaust gas turbine, to raise the output and efficiency of the engine in the simplest manner. Would it not be possible to obtain successful results by "pressure charging" in a similar way in the case of steam boilers?

Gas Turbine Not Practicable Without Steam Turbine

Another consideration leads to the same question. Apart from the exhaust gas turbine, a practical gas-turbine plant is not feasible, unless a considerable part of the power is supplied by a steam turbine, the steam for which is produced from the exhaust gases and the heat given to the cooling water, which latter cannot be dispensed with.

The gas turbine represents in this case a more or less complete steam boiler, and it only depends upon certain conditions whether the gas turbine is made the main machine, in which case the steam turbine and a compressor of large dimensions form the auxiliaries; or whether it is more suitable to make the main object the production of steam and to give up to the gas turbine only the power which is necessary to drive a compressor, which in this case is considerably smaller; the gas turbine therefor becomes an auxiliary.

The new possibilities which have been brought to light by our work on gas turbine are not exhausted with pressure charging, that is with the above-mentioned proposition of a boiler fired under pressure. These tests have also led to new discoveries with regard to combustion under constant high pressures and by explosion. Of the greatest importance however were our observations with regard to flow and heat transmission at high velocities, pressures and temperatures.

Although researches on heat transmission belong to the most thoroughly studied domains of physics and technology, test results have been completely lacking up to now at such high gas velocities and temperatures as occur in the gas turbine. These velocities are considerably higher than 650 ft. per second. They are therefore in a velocity region in which the influence of the elasticity of the gases can no longer be neglected.

Research on Gas Flow and Heat Transmission

We have carried out complete researches on flow and heat transmission at very high velocities and temperatures and have thus obtained knowledge which confirmed our opinion that important advantages would be obtained in the design of steam generators if, instead of the velocities usual up to the present, which scarcely exceed 50 ft. per second, velocities of 650 ft. per second and more were used. In order to be able to use such velocities, however, it was also necessary to find the means which would enable them to be economically produced.

Gas-Turbine Cycles

This means is offered by the gas turbine. Two different methods are possible: constant pressure with a continuous flame, for crude oil and pulverized coal; and explosion, for explosive combustibles such as gases, various oils and pulverized brown coal.

With the constant-pressure method, the combustion chamber is charged with a compressed mixture of fuel and air, the pressure of which is kept constant by means of a compressor. The gas turbine driving the compressor obtains its energy from the flue gases which flow from the combustion chamber through the heating tubes. Since, in order to produce the high gas velocities, a certain drop in pressure is necessary, only a part of the pressure drop supplied by the compressor remains available for use in the gas turbine. In order to supply the gas turbine nevertheless with the necessary power for the compressor, the driving gases must still be hot. It follows therefore that the gas turbine must be placed somewhere in the middle of the gas flow and that the heating surfaces for producing steam and heating the feed water must be placed after the turbine as well as before it.

When necessary, the blades of the gas turbine are provided with cooling. The gas turbine uses up a part of the heat of the flue gases, which is thus taken from the heat available for producing steam. An equivalent amount of heat, however, is delivered back to the combustion chamber by the work of compression in the form of compression energy and heat losses.

With the exception, therefore, of the small amount for bearing and leakage or radiation losses, no heat is lost, despite the relatively large amount of energy expended. The careful construction of the heating tubes, which are fitted with nozzles at the entrance and with diffusors at the outlet, and the recompression occurring at high velocities of flow and with intensive heat absorption, result in the actual pressure drops being smaller than would have been expected for the high velocities of flow attained.

The Explosion Cycle

In the explosion method, the combustion chamber is periodically charged with an explosive mixture of fuel and gas, which is supplied by a compressor. When charging is completed and all valves are closed, the mixture is ignited; it explodes and due to the explosion its pressure is raised to about 4 to 5.5 times the charging pressure.

At the expiration of a short period allowed for the complete combustion a discharge valve, placed at the end of the heating tubes communicating with the combustion chamber, opens. The chamber now begins to empty; the hot gases expand and flow rapidly through the heating tubes. Water is circulated on the outside of the heating tubes, absorbing all the heat contained in the gases and thus being evaporated.

The cooled gases, after having passed through the tubes, are not discharged directly into the atmosphere, but are maintained at a certain pressure before the nozzles of a gas turbine, so that they retain a certain part of their pressure drop. When the combustion chamber is emptied to about the charging pressure, the discharge valve of the pipe leading to the gas turbine is closed and a second discharge valve leading to a pipe bypassing the turbine opens, as well as the admission valve through which scavenging air and a fresh charge enters. The scavenging air and the fresh charge expel the burnt gases still remaining in the chamber through the heating tubes and the second discharge valve into the atmosphere, upon which a new cycle begins. The discharge valve and the gas turbine are placed therefore at the cold end of the heating tubes.

The admission and the discharge valves, as well as the ignition devices, are operated by oil under pressure. The frequency of the cycle is between 40 and 60 per min., this frequency varying according to the size of the combustion chamber.

Several exceedingly interesting features may be mentioned in connection with the explosion method. Due to the explosion of the compressed charge, a pressure drop is obtained, without additional external mechanical work, which suffices to impart to the gases, not only a high velocity in the heating tubes, but also energy which is used in the gas turbine. The gases give up the whole of their sensible heat to the tubes in order to generate steam and are thus cooled off before they reach the gas turbine.

If now the gases are still further expanded in the gas turbine, they are cooled down further in giving up work. The compressor is driven by this work, so that the whole of the work comes back to the combustion chamber with the compressed air and the fuel in the form of compression energy and heat losses. If, by the use of rich combustion mixtures, high explosion pressures are obtained and the feed water is at the same time at such a temperature as to cool considerably the heating gases, so that the turbine receives cold gas which is however at a sufficient pressure to act as a driving medium, it is not impossible that the flue gases leave the plant at a temperature lower than that of the surrounding air.

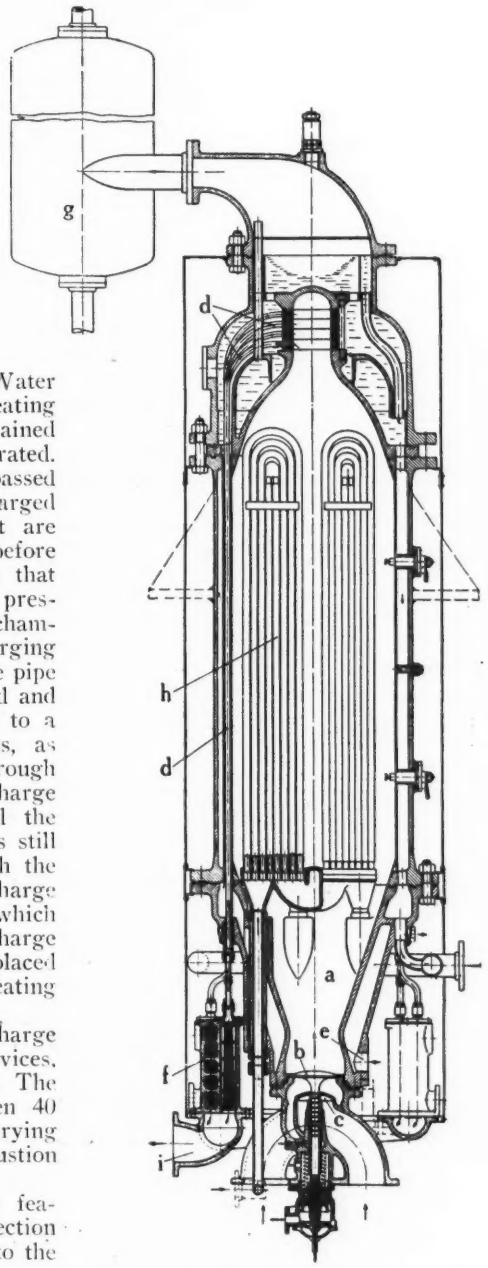


Fig. 1—Section through a small Velox steam generator for gas (explosion principle)

a combustion chamber; *b* mixing valve; *c* gas valve; *d* heating tubes; *e* circulating water inlet; *f* feed-water preheater; *g* steam separator; *h* superheater; *i* flue-gas pipe to turbine.

In this case there is more heat available for generating steam than was introduced in the fuel, which implies that the heating efficiency is greater than 100 per cent. It is evident that we have here merely an ideal case of a "heat pump" and that there is no contradiction of the second law of thermodynamics.

From both methods, explosion and constant pressure, high efficiencies are to be expected—from the explosion method on account of the recuperation of the heat of the exhaust gases used in the gas turbine—from the constant pressure method on account of the high temperatures of combustion which can be obtained—from both methods on account of the exceedingly small overall dimensions and good regulation.

The New Steam Generators

In order to give a rough idea of the dimensions which these new steam generators will have, it may be mentioned that with a charging pressure of from about 2 to 2.5 atmos. abs. and with good explosive mixtures, a combustion chamber capacity of about 35 cu. ft. is sufficient for every 1,000 kw.

When using crude oil it was possible with the constant pressure method, at a charging pressure of 2.4 atm. abs. and with a chamber capacity of 35 cu. ft., to burn sufficient fuel without smoke for an output of over 1,500 kw.

For gases, the load which can be handled by the constant-pressure steam generator ought to be still higher. In the case of brown coal dust, it seems that the explosion method requires smaller chamber dimensions than the constant pressure method.

Due to the high velocities, the heating surfaces are exceedingly small. The velocities occurring with the explosion method at the beginning of discharge attain values as high as 1300 ft. per second. They sink during discharge and scavenging to about 650 ft. per second. With the constant-pressure method, a velocity of from 650 to 1,000 ft. per second is maintained in the evaporator part. In the part after the gas turbine, the velocity is still over 350 ft. per second. The resulting heat transfer is therefore 75,000 to 100,000 B.t.u. per sq. ft. per hr. and more for the evaporator part, so that over 60 lb. of steam per square foot of heating surface can be obtained per hour. Still more important is the reduction of the flue sections.

Forced Circulation Necessary

These small dimensions of the active parts naturally necessitate, on the water side, also, large heat transfers and an active circulation of the water. The natural circulation used in ordinary boilers is no longer sufficient, and the movement of the water must be promoted by mechanical means. The steam

generators are therefore provided with a circulating pump supplying many times the quantity of water which is evaporated.

The usual steam drums are also done away with. The separation of the steam from the circulating water is effected by means of centrifugal separators, of which either one or even two in series are used, and for which the circulating pump supplies the necessary pressure drop. The separated steam goes to the superheater, which is placed, in the case of the explosion steam generator, in the combustion chamber or, with the constant pressure steam generator, partly before and partly after the gas turbine.

The steam generator plant usually consists of several chambers, each with its own separator and superheater. The circulating pump is common to all. All separators are also connected to a common container from which the supply of feed water and the pressure regulation takes place. The gas turbine and the compressor are also common to all chambers.

The power absorbed by the compressor amounts to from 10 to 25 per cent of the power which can be developed from the steam in the turbine.

If the steam generators work on the explosion principle, the cycles of operation of the separate chambers are so displaced with respect to one another that an uninterrupted flow of gas is obtained for the gas turbine and thus a continuous flow of air is produced. In the case of the constant-pressure method the division into several chambers is only determined by the output of the plant. It seems possible to obtain 10,000 kw. output from a single chamber, which can be delivered completely erected.

The regulation of the steam generator is carried out exactly as with internal combustion engines. The supply of fuel can be made directly dependent on the pressure, the steam consumption or the output of the turbine. With the constant-pressure method the output of the gas turbine, and therefore the air quantity, adjusts itself automatically. Both the constant-pressure and explosion steam generator are provided with an auxiliary motor, besides the gas turbine, with an output of about one-fifth to one-third of that of the gas turbine. This serves to supplement the output of the turbine in case of necessity and enables a quicker adjustment of the air supply to the quantity of fuel (which is influenced by a regulator) to be obtained.

It is to be expected that it will be possible with this steam generator to bring a radical simplification into future steam power houses. All the special measures which have been taken in recent years to raise the economy of steam power stations, such as high feed water temperatures, preheating of the air, raising of the pressure, reheating, heat accumulation, etc., may be dispensed with, since the new steam generator promises, without these measures, efficiencies which can only be obtained with ordinary boilers when these special steps are taken.

It is to be noted in this connection that, in the present case, the air preheater is replaced by the compressor, and the heat accumulator by the large range of regulation and immediate readiness for service of the plant. For heating the feed water outside the steam generating plant, only the steam coming from the glands and that produced from the drainage of the last stage of the turbine will be used.

A considerable simplification will also be obtained in future plants by the elimination of the boiler house. The reduced dimensions and the gas-tight enclosure of all parts will probably enable, in many cases, the steam generator to be placed in the condenser basement, in the engine room itself, or even in the open air. Great lengths of piping will therefore no longer be required. An exhaust pipe similar to that used with diesel engines will serve as chimney.

Although, with the above particulars, we make public activities in this connection, it is not intended to give the impression that development work on this steam generator is already so advanced that we wish to, or could, put such plants on the market and give the customer every desired guarantee. The stage reached by the preliminary work, tests, and patents, as well as the rumors already circulating in technical circles, seem to make it preferable to publish now our work and proposals in this direction. Moreover, we are under the impression that this information will be welcome to many who are planning new installations, the realizations of which, however may, for other reasons, still be postponed for a certain time.

As will be realized from the foregoing, only explosive or very finely divided fuel, which burns with as little deposit as possible, can be used in the new steam generator.

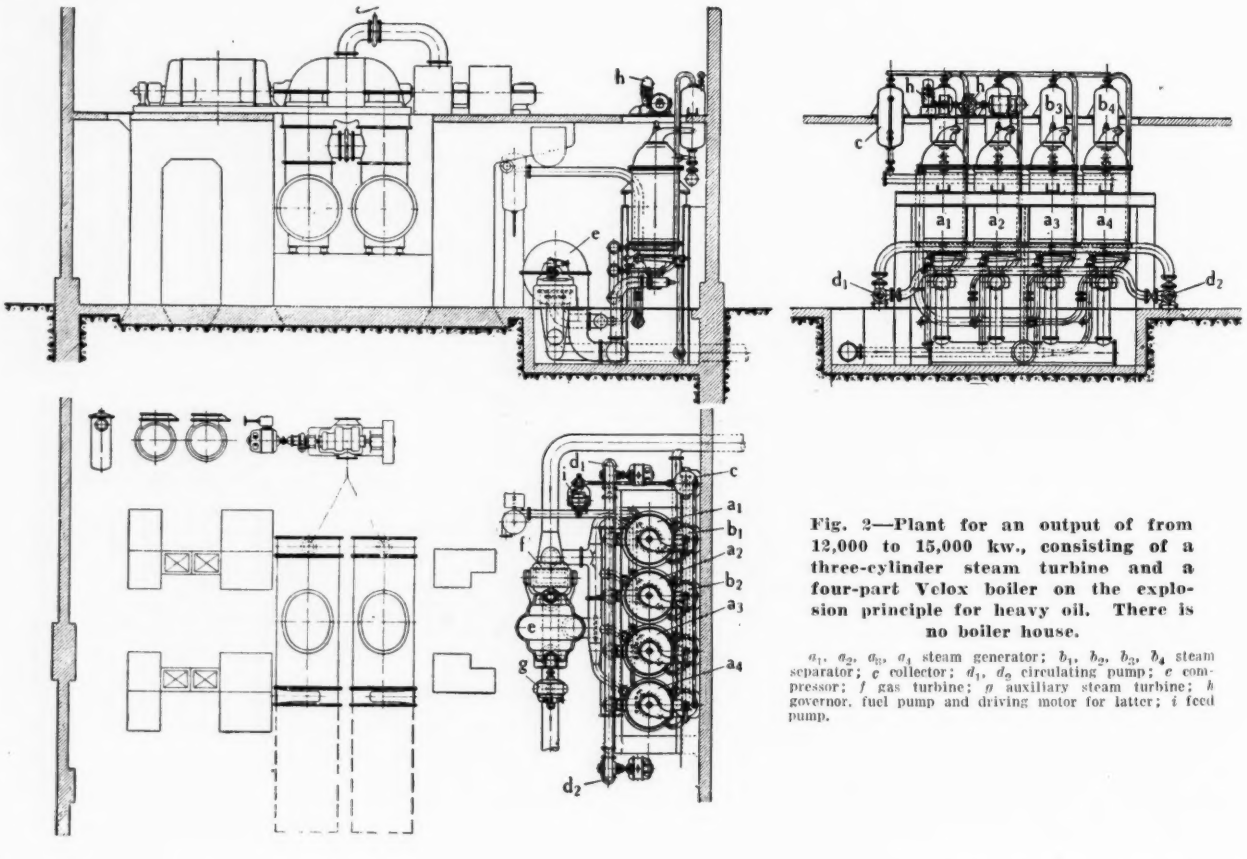
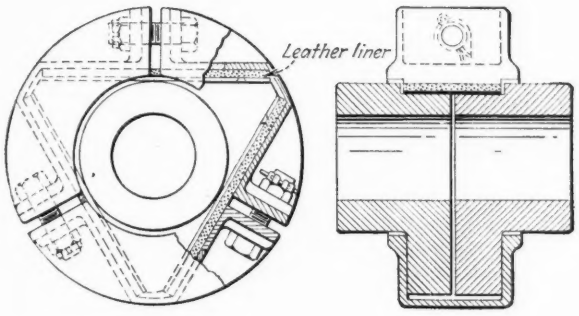


Fig. 2—Plant for an output of from 12,000 to 15,000 kw., consisting of a three-cylinder steam turbine and a four-part Velox boiler on the explosion principle for heavy oil. There is no boiler house.

a_1, a_2, a_3, a_4 steam generator; b_1, b_2, b_3, b_4 steam separator; c collector; d_1, d_2 circulating pump; e compressor; f gas turbine; g auxiliary steam turbine; h governor, fuel pump and driving motor for latter; i feed pump.

WHAT'S NEW IN PLANT EQUIPMENT



Section through Triplex heavy-duty coupling

Leather Lined Couplings

THREE new couplings, "Triplex" for heavy duty, "Simplex" for medium duty, and "Marine" for marine service, are announced by the Clark Coupling Company, 149 Church St., New York, N. Y.

The "Triplex" coupling consists of a three-piece housing which is bolted together, and on the inside face of which are fastened leather liners. The housing transmits the power from the driving triangular face hub to the driven hub of similar form, as shown in the cross-sectional views. The leather liners are said to make the coupling noiseless and to cushion against shocks.

In the "Simplex" coupling the transmission element is a floating triangle fitting into a triangular recess in each hub. The triangle is metal faced with leather, the action being the same as in the "Triplex" coupling.

The "Marine" coupling is similar to the "Triplex," except that the material used is non-corrosive, and arrangement is made for taking thrust.

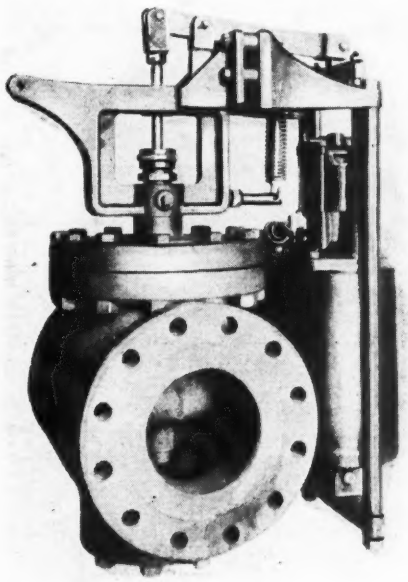
Couplings are made in sizes from 1 in. to 5 in., and in horsepower varying from 0.4 hp. to 60 hp. per hundred revolutions per minute, the largest coupling being suitable for transmitting 900 horsepower at 1,500 revolutions per minute.

Thrustor-Operated Valve gives Centralized Remote Control

FOR CENTRALIZED remote control of gases or liquids under pressure, a Thrustor-operated valve is announced by the General Electric Company, Schenectady, N. Y. It is available in sizes ranging from 2 to 12 in. for 125 to 600 lb. pressure and is designed for general industrial applications particularly where centralized remote control is desired.

In operation, the Thrustor, a self-contained power unit consisting of a motor controlling an improved hydraulic cylinder, applies pressure to the valve to open or close it. A spring returns the Thrustor to its original position.

The operating cylinder is readily adjustable for rapidly or slowly opening valves. This is accomplished by controlling the flow of oil from under the plunger by means of an external adjustment. By this means the valve can be made to close slowly without shock or hammer in the pipe line. The valve is positive in opening and closing, since it is direct-connected, and requires less time than a motor valve to operate. In addition, no overload protection is necessary in the motor circuit, since the Thrustor can go to the extreme limit of its travel without overloading the motor. No limit switches are necessary. Because of the small amount of current consumed by the Thrustor motor, a small relay may be used to handle the unit.



Thrustor applied to a 12-in. hydraulic valve

Two-Speed Reversing Gear A Compact Unit

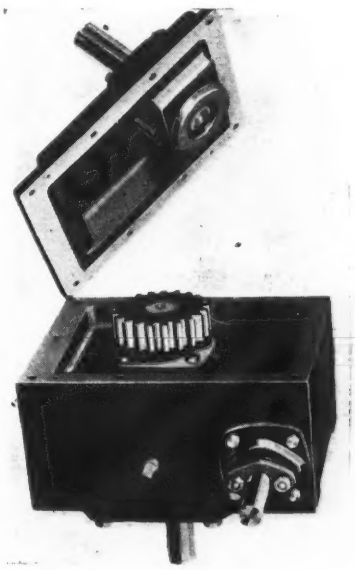
A TWO-SPEED reversing unit, originally designed for a traversing head on a linoleum plant machine, but applicable to a wide range of use, is offered by the Ohio Gear Company, 133 East 179th St., Cleveland, Ohio.

The two speeds may be arranged for one-to-one ratio, or any other reasonable ratios likely to be met with in such service. The shaft may be arranged to be on opposite sides of the housing, or on the same side, and to operate in the same or opposite directions, as may be desired. All gear teeth are permanently in mesh.

The unit can be arranged to operate shafts with centers several inches apart. If a Hookes joint or similar device is added, it can also operate shafts which are out of line, as well as out of center.

The unit is completely inclosed and provided with grease-lubricated ball bearings.

When used as a substitute for beveled gear reverse, it permits the clutch to be placed where most convenient, instead of necessarily between the two ends of the shaft, where, as a rule, there is little room to spare.



Reversing gear with cover plate removed

Acid-Proof Packing

"SUPER-CUTNO" is the name of a new packing which has been developed by Greene, Tweed & Company, 109 Duane St., New York City, for service with sulphuric, nitric and other highly corrosive acids. This packing consists of asbestos lubricated with a compound which is said to resist the action of acids, even at high temperatures. The manufacturers state that the compound is retained in the packing as long as possible, in order to prevent the packing from hardening and scoring the pump shaft.

NEWS of the FIELD

New High-Pressure, High-Temperature Unit Goes Into Service at Burlington Station

THE FIRST high-pressure boiler and turbine-generator to be installed in the system of the Public Service Electric & Gas Company of New Jersey has just been put into commercial operation at the Burlington generating station, following a period of preliminary tests.

The steam generating unit and the turbine-generator are the first central station equipment in this country to employ steam at a pressure of 730 lb. per sq.in. and a temperature of 860 degrees Fahrenheit.

The new high-pressure exhaust turbine-generator has a capacity of 18,000 kw. and operates at 3,600 r.p.m. It is the first unit of its size to run at such a speed in this country. The high-pressure boiler, which is fired with pulverized coal, is over 100 ft. in height and has already produced under test more than a half million pounds of steam per hour. The boiler has a greater capacity than the combined output of the ten boilers now installed in the station, all of which have been shut down since the new unit was put into service. These boilers will be kept in reserve for emergency use.

A feature of the station's design is the manner in which the high-pressure steam is utilized at lower pressure to operate the three other turbines in the station, resulting in improved station efficiency. The high-pressure turbine exhausts into a low-pressure steam header, which in turn supplies the three original units operating on 200 lb. pressure.

As a result of the new installation the generating capacity of Burlington station has been increased from 35,000 to 53,000 kilowatts.

Four 25,000-Sq.Ft. Boilers For Federal Heating Plant

CONTRACT for the new Triangle heating plant which will serve 22 of the new federal buildings in Washington, D. C., has just been awarded by the United States Treasury Department to the Combustion Engineering Corporation, New York City.

The contract, the largest awarded in the boiler field this year, calls for four 25,000-sq.ft. Walsh-Weidner sectional-header boilers and four multiple-retort stokers, together with steel-encased boiler settings, water-cooled furnaces and forced and induced draft fans and drives.

Designed for 400 lb. pressure, the boilers are guaranteed for a production of 215,000 lb. of steam per hour continuous and 237,000 lb. maximum, from and at 212 deg. F. The stokers will be 15 retorts wide, 45 tuyeres long, and will have a projected grate area of 480 sq.ft. each. They will be equipped with double-roll clinker grinders.

The government architect and engineers have designed the heating plant to harmonize with the architecture of the surrounding buildings in the new federal building development. It is estimated to cost $5,000,000, and particular pains have been taken to make it a model plant in every respect. The consulting engineers are United Engineers and Constructors, Inc., Philadelphia, and the architect is Paul Crat, designer of the Pan-American Building. Erection will be completed in nine months.

New Viscosity-Temperature Chart Adopted by A.S.T.M.

A NEW viscosity-temperature chart for lubricants and petroleum products has just been adopted as a tentative standard by the American Society for Testing Materials. Covering a temperature range from —30 deg. F. to 450 deg. F. and a viscosity range of 37 to 100,000,000 Saybolt universal seconds, this chart incorporates the best features of all previous charts used, including the generally employed charts of Larson and MacCoull.

The new chart is useful for the solution of many problems, such as those involving a prediction of lubricant performance under varying temperature conditions. It is also an aid in friction and heat calculations, since a convenient, accurate kinematic-viscosity scale has been placed along the edge of the chart, making it easy to convert Saybolt seconds to fundamental viscosity units. In addition to petroleum products, the chart may be used for any other liquid, such as castor oil, glycerine, lard, oil, coal tar products, etc., with good results.

Printed on thin, tough paper that permits handling without damage, the chart measures 16½x21½ in. It will be available from the headquarters of the A.S.T.M. at 1315 Spruce St., Philadelphia, Pa., about April 10 at 25c. per single copy, $1.50 per pad of 25 or $5 for four pads.

Shoals Bill Unlikely To Pass This Session

PROVISIONS written into the Muscle Shoals bill by the House Committee conflict so much with the sentiments of the sponsors of the measure in the Senate, that the final passage of legislation on the subject is doubtful this session. The bill appears to be headed for the inevitable conflict between the two Houses of Congress. In its report recently filed with the House, the House Committee takes the position that the door should not be closed to any prospective lessee even though the time limit fixed for the negotiation of a lease may have expired. Thus, if the Muscle Shoals Commission fails to obtain a satisfactory lease within eighteen months, government operation would be authorized until such time as a lease could be obtained.

Senator Norris, who is the author of the Muscle Shoals bills that have been submitted to the Senate during the last decade, is unalterably opposed to any legislation that would make government operation conditional. He is willing to compromise on any time limit that the House may propose before government operation is undertaken, but after this period has elapsed he is opposed to any provision that would open up the matter again. Senator Norris also is opposed to any Muscle Shoals legislation that does not provide for the construction of government transmission lines in the event that a lease can not be obtained. The House bill makes no such provision. Unless there are publicly owned transmission lines, Senator Norris does not believe that the government would be able to distribute the surplus power at rates that would be sufficiently low.

A minority of the House Committee has entered a separate report opposing any plan for government operation. It is contended that such procedure "would

result in doing violence to the fundamental principles of our system of government." The dissenting members feel that the leasing provisions that have been written into the House bill are so drastic that it is doubtful that a lease could be obtained.

Plan Natural Gas Line For San Diego, Calif.

SAN DIEGO, Calif., is to be served with natural gas about Sept. 1, 1932, according to an announcement by president W. F. Raber, of the San Diego Consolidated Gas & Electric Company.

Construction of 95 miles of $12\frac{3}{4}$-in. transmission main from Long Beach, Calif., will be required. It is estimated that the cost will reach a million and a half exclusive of the installation of a Butane enrichening plant which is to be installed in connection with the existing manufactured gas plant as an emergency measure.

The natural gas is to be purchased from the Southern Counties Gas Co. of Los Angeles, which secures its natural gas supply from the combined fields of Kettleman Hills, Ventura, Santa Barbara and Long Beach.

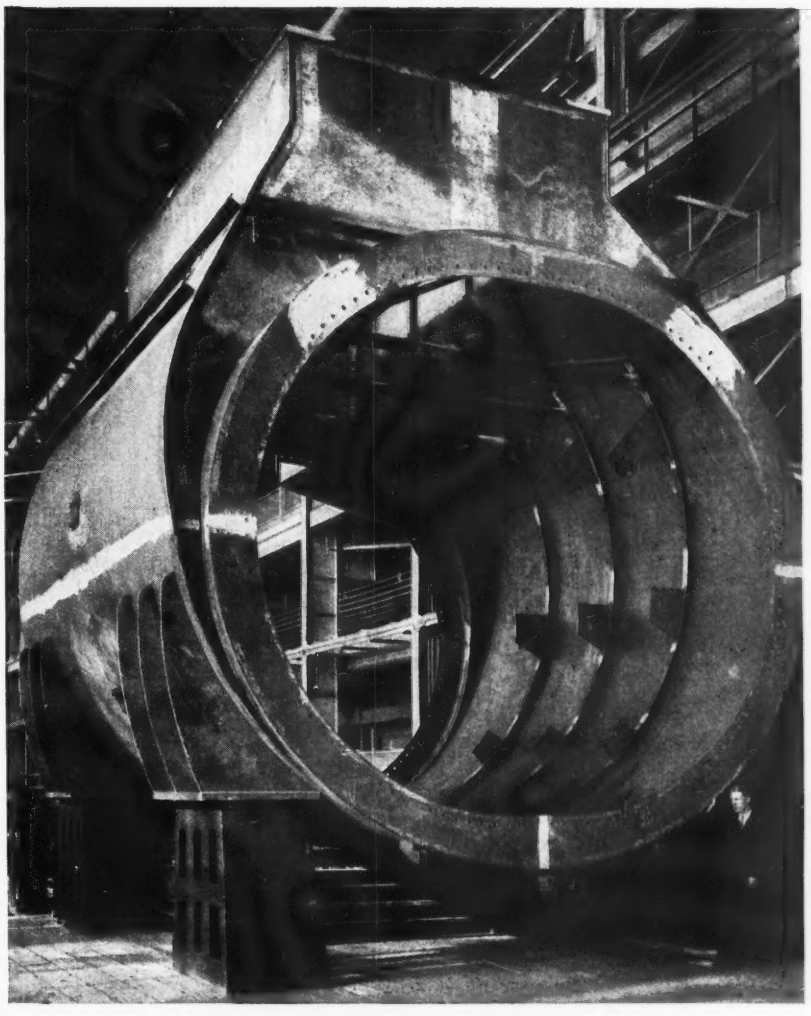
Agree on Essential Terms Of St. Lawrence Treaty

ACCORDING TO opinions being expressed in political circles at Ottawa, there are now few problems blocking the St. Lawrence waterway pact between Canada and the United States. On the principal engineering features there is understood to be an agreement between the two countries; similarly, there is believed to be agreement over the division of cost.

Two problems now confronting the Canadian Government include the price to be paid by the Ontario Hydro Electric Power Commission, through the Ontario Government, for the 900,000 hp. to be developed on the Canadian side of the proposed waterway, and over what term of years that payment is to be made by Ontario to the Dominion; also the continued opposition of the Quebec Government.

It has been reported that an agreement is near completion between the Federal Government and the province of Ontario involving development of the 900,000 hp. at a busbar cost of $15 per horsepower on the Canadian side of the international section of the river. It has been estimated that the cost of the Ontario development will be in the neighborhood of $115,000,000, including generators and other machinery. Of this $115,000,000, a sum ranging up to $75,000,000 will be Ontario's contribution to the cost of the joint navigation and power works necessary to the seaway.

65,000-SQ.FT. CONDENSER FOR KEARNY



A 65,000-sq.ft. condenser has just been completed at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company, to serve the new 75,000-kw. single-cylinder unit being installed in the Public Service Electric & Gas Company's plant at Kearny, N. J. Fabricated in two parts to facilitate shipping, the condenser measures 34½ ft. long, 30½ ft. high and 22½ ft. wide

▼ ▼ ▼

Safety Council Offers New Accident Prevention Service

ON THE THEORY that every industrial concern is entitled to the benefits of organized accident prevention the National Safety Council has just announced a practical plan for spreading the gospel of safety throughout industry.

"Every company, large or small, regardless of whether it holds membership in the council, can have that organization's help in establishing a definite working plan for a continuous campaign of accident prevention," the announcement states.

"The safety work of several thousand industrial members in all industries has recently been analyzed and their most effective technique will be made available to any plant desiring a specific course of safety procedure without cost. The sole obligation on the part of the employer will be to provide a few essential facts from which council engineers can draw up a practical working plan commensurate with the needs of the company and applied to the specific operating problems.

"Also as a result of this survey a new service is offered by the council to old and prospective new members. It is known as "complete industrial" service and is exactly what its name implies—adequate, sufficient, all-inclusive. It represents a high standard in safety technique and reaches not only management, key safety men and foremen but also every employee.

"In the past warfare on accidents has been directed mainly by foremen and safety engineers. The new plan takes cognizance of the fact that it is really everybody's business, and each employee's interest is awakened and sustained through a twelve-month schedule of safety contacts."

Headquarters of the National Safety Council are at 20 North Wacker Drive, Chicago, Ill., to which all inquiries regarding the plans should be directed.

U. S. Chamber to Discuss Economic Cycle, May 17-20

BUSINESS will come to grips with the economic cycle, its most formidable enemy, at the twentieth annual meeting of the Chamber of Commerce of the United States, to be held this year at San Francisco, Calif., May 17 to 20.

This will not be a concerted frontal attack based on a theoretical plan, the Chamber announced, but the advance will be launched virtually all along the economic battle line, in manufacturing, distribution, construction, insurance, agriculture, mining, lumbering, and it will be directed against economic realities and aim at the flattening of economic salients which stand in the way of a general approach to industrial and trade stability.

The subject of business planning to meet immediate problems will be considered at a special group session of the meeting. Possibilities and effects of planning, from the viewpoint of the individual industrial concern, the entire industry as represented by its trade associations, the community and the region will be weighed in the light of practical experience. This involves the answering of such questions as the effects of industrial company planning on the volume and stability of production and sales, profits and continuity of employment; what cooperative plans requiring group action must be developed to assure stability in an entire industry, and what measures state and regional organizations may adopt to stabilize industrial and employment conditions in their respective localities.

Management Congress at Amsterdam, July 18-23

ENGINEERS AND INDUSTRIALISTS from the United States will take part in the International Congress for Scientific Management to be convened in Amsterdam, Holland, from July 18 to 23. The Congress is under the jurisdiction of the International Committee on Scientific Management with offices in Paris and under the direct supervision of the Dutch Committee with headquarters in Amsterdam.

Participation from this country is being handled by the International Management Congress Committee of the United States with the cooperation of the following societies: American Management Association, American Society of Mechanical Engineers, Taylor Society, Society of Industrial Engineers, National Association of Cost Accountants, American Home Economics Association, and the American Society of Agricultural Engineers.

The program will consist of one hundred papers from authors throughout the world, discussing the following twelve subjects: Uniform cost accounting and standard costs, budgets as a basis for bank credit, market studies, training foremen, rational promotion systems, college courses for management, increasing worker efficiency, household budgets, stock turnover, engineering advances in dairy production, applications of scientific management and incentive wage-payment plans for office work.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Heaquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Baltimore Section. Meeting at the Engineers Club, April 21 at 8:15 p.m. Subject: "Smoke Abatement and the Engineer," Col. Elliott H. Whitlock.

A.S.M.E., Chicago Section. Meeting in the Engineering Building, April 25 at 7 p.m. Subject: "Utilization of Low-Grade Coals," C. F. Gebhardt.

A.S.M.E., New Orleans Section. Meeting at the Cabildo, April 21 at 8:30 p.m. Subject: "The Economic Status of the Mechanical Engineer," James M. Todd.

Steel Founders' Society to Meet in New York, May 18

THE SPRING MEETING of the Steel Founders' Society of America will be held on May 18 at the Hotel Roosevelt, New York City. On the following day the regular meeting of the Heat-Corrosion Alloy Founders' Division will take place.

Among the features of the Steel Founders' gathering will be a report of the Joint-Cost Committee, containing a new series of operating data designed to increase efficiency and reduce costs; a discussion of "Deflationary Buying and Destructive Selling," and its effect on general business; and a paper on "The Cost of Dust in the Steel Foundry," by Clarence B. Bartlett, industrial analyst of Milwaukee. Mr. Bartlett, for the past year, has been managing engineer of a committee of the Wisconsin Manufacturers' Association on dust, fumes, vapors and gases, under the chairmanship of Harold S. Falk of the Falk Corporation.

Subjects to be discussed at the Alloy Division meeting include standard analysis specifications for the various grades of alloys; a code of ethical trade practices for the industry; a uniform guarantee for the protection of buyer and seller; a uniform method for arriving at the cost of metal; and the development of engineering standards applying to various grades of alloys for high-temperature and corrosive service.

Berlin Plans Windmill Power Plant on 1,300-Ft. Tower

HUGE WINDMILL-GENERATORS, capable of producing approximately 700,000,000 kw.-hr. annually, will be installed on top of a 1,300-ft. steel tower that Hermann Honnef, engineer, plans to erect in Berlin, Germany, according to a special cable to the New York Times, April 6. The German Ministry of Transportation has rendered a favorable report on Mr. Honnef's plan for the tower, which will be the tallest structure in the world. The output of the generators, it is stated in the proposal, will be used for heating hothouses around the tower.

Buried in Crushed Coke, Not Pulverized Coal

THE TWO LABORERS who lost their lives in the accident occuring March 22 at the Brooklyn Union Gas Company's plant at Maspeth and Varick Avenues, Brooklyn, N. Y., fell into a bin containing crushed coke, not pulverized coal as reported on page 492 of *Power* for March 29. They sank rapidly in the finely divided coke and died of suffocation.

Personals

E. G. CAHILL, of the Cahill Brothers, San Francisco contractors, has just been appointed manager of the city's public utilities by the Public Utilities Commission. The San Francisco Municipal Railway, the Hetch Hetchy water and power system, the city water department and the municipal airport will be under the management of Mr. Cahill.

A. V. WINTER, American engineer who supervised construction of the 800,000-hp. hydro-electric project on the Dnieper River in Soviet Russia, has been appointed director of a new organization to handle the erection of three water-power plants on the Volga River, with a total capacity of 1,000,000 kw. According to an official decree of the Soviet Government, construction will begin at once and is to be finished by 1935. The plants will be erected entirely on the basis of Soviet technique.

JOHN W. BAUMGARTNER, who was recently appointed to the Los Angeles Board of Water and Power Commissioners, has been elected president of the board to succeed ARTHUR STRASBURGER.

RICHARD H. MCKAY, electrical engineer for the Washington Water Power Company and chairman of the Associated Engineers of Spokane, has been appointed district manager for the power company at Coeur d'Alene, Idaho, to succeed J. W. VOELLMECK, resigned.

Obituary

EBEN M. BYERS, chairman of the board of the A. M. Byers Company, Pittsburgh, Pa., died on March 31 in the Doctors' Hospital, New York City, of radium poisoning caused by drinking a "radium water" put up for medicinal purposes. Mr. Byers was the son of the late Alexander M. Byers, who founded the A. M. Byers Company. He was graduated from Yale University in 1901 and immediately entered the company, serving in various executive capacities until the death of his father, when he was made chairman of the board.

FRED H. THOMAS, vice-president and general sales manager of the Cooper-Bessemer Corporation, Mt. Vernon, Ohio. died of heart failure on March 27 at his home. His death followed a four months' illness. Mr. Thomas went with the former C. & G. Cooper Company in 1907, after two years with the Babcock & Wilcox Company and the United States Steel Company. For the past fifteen years he had been vice-president and general manager of the merged company which resulted from the consolidation of the C. & G. Cooper Company and the Bessemer Gas Engine Company.

How's Business?

THE SECOND QUARTER began by establishing new lows in business indicators, security markets and commodity price levels. The automobile sales drive has not yet been reflected in expansion in steel production or electric power output (1,480,208,000 kw.-hr. for the week ended April 2 according to the N.E.L.A.), while unseasonably declining merchandise carloadings and bank debits indicate further recessions in retail trade. Building construction seems to be stabilizing at bare subsistence levels. Budget balancing has not proven as much of a blessing as was anticipated, and some of the taxes employed for the purpose have stimulated sabotage and short-selling in security markets. Reconstruction Corporation activity has reduced bank suspensions and individual hoarding but increased bank hoarding.—*The Business Week,* April 13.

Business Notes

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., and the DAYTON RUBBER MANUFACTURING COMPANY, Dayton, Ohio, announce that their suit in the United States District Court at Cincinnati, involving infringement of the Allis-Chalmers Geist patent No. 1,662,511 pertaining to multiple V-belt drives, has been settled out of court by a working agreement, under which the Dayton company takes a license under the Geist patent and Allis-Chalmers can operate under the Short patent No. 1,538,303.

BABCOCK & WILCOX TUBE COMPANY, Beaver Falls, Pa., announces the opening of a new branch office in the Ford Building, Detroit, Mich. J. E. Polhemus, formerly vice-president and district sales manager of the Detroit branch of the Associated Alloy Steel Company, Cleveland, Ohio, has been placed in charge of the new office.

WORTHINGTON PUMP & MACHINERY CORPORATION, Harrison, N. J., has appointed Frank R. Wheeler special sales representative, with headquarters at the Chicago office. He will cover the Midwest territory, assisting Worthington branches in Chicago, St. Paul, Kansas City, St. Louis and Detroit. Mr. Wheeler was formerly manager of the condenser department of the Elliott Company, Jeannette, Pa.

DIAMOND CHAIN & MANUFACTURING COMPANY, Indianapolis, Ind., has appointed several new Pacific Coast representatives. The Puget Sound Machinery Depot will represent the company in Oregon and Washington, with stocks carried at Klamath Falls, Portland, Hoquiam and Seattle. Joseph D. Christian Engineers of San Francisco have been made engineering representatives, and the Horsford Brothers Company of the same city have been appointed industrial distributors for northern California. In the Los Angeles territory the Goddard Jackson Company are now Diamond Chain representatives. Complete stocks will be carried in both San Francisco and Los Angeles.

MCCLAVE-BROOKS COMPANY, Scranton, Pa., announces the appointment of the Proctor Engineering Company, 28 South Gay St., Baltimore, Md., as sales and service representative in Maryland, Virginia and the District of Columbia.

Trade Catalogs

FANS—The many ventilating and air-conditioning applications of ILG self-cooled motor-driven propeller fans are fully illustrated and described in a new catalog of the ILG Electric Ventilating Company, 2850 North Crawford Ave., Chicago, Ill. In addition the catalog contains complete specifications, construction details and installation instructions for the various units.

STEAM GENERATOR—An illustrated description of the "Ghapco" steam generator, an automatically controlled boiler and burner unit, is contained in a new bulletin of the General Heat & Power Corporation, 101 Park Ave., New York City. Sectional drawings, specifications and test data are included.

REFRIGERATION—A new method of refrigeration by evaporating, under high vacuum, a portion of the water or brine to be cooled, is described in Bulletin W.J.-31-3, entitled "Vacuum Refrigeration Systems," just issued by the Foster Wheeler Corporation, 165 Broadway, New York City. Typical installations are illustrated.

CO_2 METERS—Complete data on the various types of Republic CO_2 meters is contained in Catalog No. 401, just issued by the Republic Flow Meters Company, 2240 Diversey Parkway, Chicago, Ill. This catalog is effectively illustrated and presents much information pertaining to combustion problems.

CONVEYORS—Various applications of the belt conveyor in some 27 different industries are described and illustrated in a new bulletin of the Diamond Rubber Company, Akron, Ohio, entitled "How Shall We Handle It?" Construction features, sizes and specifications of Diamond conveyor belts are also given.

REFRACTORIES—Bulletin 1-13-17, just issued by E. J. Lavino & Company, Bullitt Building, Philadelphia, Pa., illustrates the standard shapes of 9-in. chrome brick.

NEW PLANT CONSTRUCTION

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Birmingham—Alabama Power Co., 600 North 18th St., plans to expend $100,000 in reconstruction program made necessary by recent tornadoes over the state. Work includes rebuilding of 44 kv. sub-station, transmission lines, and distribution systems, etc.

Calif., Pasadena—City awarded contract for furnishing circuit breakers for use in municipal light and power department, to Kelman Electric Co., 1650 Naud St., Los Angeles. $10,000.

Calif., Sunnyvale—Bureau of Yards & Docks, Washington, D. C., will receive bids until April 13 for construction of underground electric distribution system including conduit, transformers and accessories at Naval Air Station here.

Calif., Yosemite National Park—C. H. Sweetser, Dist. Engr., c/o Bureau of Public Roads, 461 Market St., San Francisco, will receive bids until April 14 for enlarging ventilating adit in highway tunnel on Wawona Rd., Yosemite National Park.

Colo., Denver—Board of Commissioners, Denver Water System, having plans prepared for construction of a new pumping station at South University Blvd. and East Jewell Ave. $200,000. This is part of $1,500,000 improvement project. R. E. Stiffler, 1925 Ivanhoe St., Denver, is architect. Everything will be electrified.

Colo., Grand Valley—Bureau of Reclamation, Denver, will receive bids until April 28 for construction of addition to present power plant, Grand Valley power project here. R. F. Walter, Denver, is chief engineer.

Conn., New Britain—Southern New England Ice Co., R. G. Hadley, Gen. Mgr., Corbin Pl., awarded contract for construction of a 1 story, 60 x 120 ft. ice manufacturing plant on West Main St., to Carlson & Torre Co., 805 Main St., also 1 story, 60 x 120 ft. ice plant at Meriden to Bartlett-Brainard Co., 252 Asylum St., Hartford. Estimated cost $100,000 each.

Conn., Versailles—Crystal Ice Co., 101 West Main St., Norwich, awarded contract for construction of a 1 story, 60 x 90 ft. ice manufacturing plant here to John A. Monty, Farnsworth St., New London. Estimated cost $50,000.

Conn., West Haven—Hygienic Ice Co., 881 State St., New Haven, awarded contract for addition and alterations to ice manufacuring plant on Elm St. here to Fusco & Amatruda, 59 Amity Road, New Haven. $40,000.

D. C., Washington—Treasury Department, Office of Supervising Architect, will receive bids until May 16 for construction of Department of Labor building, Interstate Commerce Commission building and connecting wing. Estimated cost $9,000,000.

Ga., Austell—Southern Ice Co., c/o R. J. Hancock, Pres., Marietta, having plans prepared for construction of a 1 story ice plant here. Robert & Co., Bona Allen Bldg., Atlanta, are engineers. Work will be done by owner's forces.

Ill., Lansing—City plans construction of a sewage treatment plant and pumping station. Estimated cost $125,000. Consoer Older & Quinlan, 205 West Wacker Drive, Chicago, are engineers. Appropriation made for purchase of site.

Ind., Greencastle — Depauw University, will build a heating plant including boiler, smoke stack, 130 ft. high, new coal and ash hoisting equipment, boiler feed pump, etc. Estimated cost $40,000. Work will be done by separate contracts.

Mass., Bedford—Veterans' Bureau, c/o Col. L. H. Tripp, Arlington Bldg., Washington, D. C., awarded contract for coal bunker, stoker equipment, etc., for Veteran's Administration Hospital here, to Pasquale Construction Co., 91 Williams St., Jamaica Plain. $25,000.

Mich., East Lansing — State Administrative Board, Lansing, awarded contract for construction of a 2 story administration building, dining hall and boiler house addition at State Police building here, to F. C. Trier, Saginaw. $61,152.

Mich., Saginaw—Genese Coal & Ice Co., Flint, awarded contract for construction of a 1 and 2 story ice plant, 65 ton daily capacity on Phelon St. here to Spence Bros., Saginaw. Estimated cost $75,000. Electric motors, etc., will be installed.

Minn., St. Paul—State Building Commission, Henry Rines, Secy., 308 State Capitol, received lowest bid for furnishing and installing additional generator unit for power plant at State Capitol, from Filer & Stowell Co., 219 Becher St., Milwaukee, Wis. $28,800.

N. Y., Brooklyn—Public Works Officer, Navy Department, awarded contract for alterations and improvements to boiler room at Navy Yard to Har & Early, 18 East 41st St., New York. $11,480.

N. Y., Dannemora—Department of Correction, State Office Building, Albany, will receive bids until April 14 for construction, heating and electric work for steam duct from Clinton Prison power house duct and service connections at Dannemora State Hospital here.

N. Y., New York—New York Steam Co., 280 Madison Ave., budget for 1932 $2,500,000 includes extensions of underground steam mains and facilities in connection radio city project.

Ohio—City Ice & Fuel Co., 6611 Euclid Ave., Cleveland, plans construction of a cold storage plant at Elyria, also at Geneva. Estimated cost each to exceed $40,000.

O., Chillicothe—Department of Justice, Bureau of Prisons, Washington, D. C., will soon award contract for delivering and installing ice making and refrigeration plant here.

O., Cincinnati—Western & Southern Life Insurance Co., having sketches made for construction of an office building at Broadway between 4th and 5th Sts. here. $2,000,000. D. E. Waid, 1 Madison Ave., New York, N. Y., is architect. C. J. Keifer, Schmidt Bldg., Cincinnati, is engineer.

O., Eaton—Town, O. H. Swain, Clk., having plans prepared for construction of a municipal light plant. Fosdick & Hilmer, Union Trust Bldg., Cincinnati, are engineers.

Okla., Oklahoma City — Oklahoma Gas & Electric Co., plans completed for construction of a power duct system at Harvey Robinson and Hudson Sts. Estimated cost $25,000. Byllesby Engineering Co., 231 South La Salle St., Chicago, Ill. $25,000.

Texas—J. J. Harpey, Hitchcock, acquired cold storage and refrigeration plants at Hitchcock, Alta Loma, Arcadia and Algoa, also ice manufacturing plant at Hitchcock. Will have surveys made soon for improvements.

Wash., Ellensburg — Bureau of Reclamation, awarded contract for construction of Wippel pumping plant, Kittitas Division, Yakima project to L. Coluccio & Co., 1638 Lane St. $13,713. Equipment not yet purchased.

Wash., Vancouver—City Council will receive bids about June 1 for construction of a Diesel powered electric generating plant for furnishing current for street lights. Estimated cost $35,000. A. J. Collings, Councilman.

Wis., Racine—Board of Water Commissioners, will soon award contract for construction of waterworks sub-station including switches and all accessories. Alvord, Burdick & Howson, 20 North Wacker Dr., Chicago, Ill., are engineers.

W. Va., Cabin Creek—Appalachian Electric Co., c/o E. A. Turner, plans condenser alterations, etc., in electric power plant. Estimated cost to exceed $40,000. Work will be done by day labor.

N. S., Truro — City Council is considering changing waterworks pumping system from steam to electric.

United Soviet Socialist Russia, c/o Amtorg Trading Corp., 261 5th Ave., New York, N. Y., plans completed for construction of a hydro-electric development on Vyg River at Karelia to supply additional power to Leningrad district. Estimated cost to exceed $10,000,000. Work will be done by day labor and technical aid contracts.

Equipment Wanted

Boiler—Montana—Quartermaster, Fort Missoula, will receive bids until May 1 for one 2,500 sq.ft. steam boiler. Cir. 13.

Engine—Canal Zone—Constructing Quartermaster, will receive bids until April 21 for a 3 cylinder marine gasoline engine at Fort Sherman. Cir. 5.

Condenser, Pump and Air Ejector — Portsmouth, N. H.—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until April 20 for condenser, pump and air ejector, 16,000 lb. per hour steam capacity for Navy Yard here.

Electrical Supplies—Brooklyn, N. Y.—Signal Supply Officer, Army Base, will receive bids until April 25 for electrical supplies including seventy-five transformers, etc. Cir. 121.

Power Plant Equipment—Brooklyn, N. Y.—Department of Mental Hygiene, State Office Bldg., Albany, will receive bids until April 13 for power plant equipment at Brooklyn State Hospital here.

Pumping and Power Equipment—Elaine, Ark.—Elaine Utilities Co., c/o H. H. Thompson, 3891 Galloway Drive, Memphis, Tenn., plans to purchase new equipment for waterworks system, also light plant and telephone system. Estimated cost $30,000.

Industrial Projects

Ga., Rossville—Peerless Woolen Mills, will build a 3 story, 100 x 300 ft. warehouse and processing plant. Estimated cost $100,000. W. H. Sears, James Bldg., Chattanooga, Tenn., is architect. Work will be done by day labor and separate contracts. Former bids rejected.

Mass., Weymouth — Crawford Machine Co., Central Ave., plans to rebuild factory recently destroyed by fire. Estimated cost $50,000. Work will be done by separate contracts.

N. J., Carteret — Mexican Petroleum Corp., 122 East 42nd St., New York, N. Y., preparing plans for addition to plant here. Estimated cost to exceed $40,000.

N. J., Rahway—Merck & Co. Inc., Lincoln Ave., awarded contract for a 1 and 2 story addition to chemical manufacturing plant, to Robert E. Lamb Co., 841 North 19th St., Philadelphia, Pa. $150,000.

N. J., South Amboy—Titanium Pigment Co., c/o W. F. Meredith, 60 John St., New York, N. Y., plans construction of a plant, machine shop, etc., here. Estimated cost $1,000,000.

Va., Alexandria — Ford Motor Co., 3674 Schafer Road, Dearborn, Mich., awarded general contract for construction of a 1 and 2 story automobile assembly plant here to Worden-Allen Co., 208 South La Salle St., Chicago, Ill. Estimated cost $500,000. Electric power equipment and complete assembly line equipment and conveyors will be installed.

Va., Rocky Mount—Bald Knob Furniture Co., plans to rebuild part of plant recently destroyed by fire. Cost exceeds $40,000. Maturity indefinite.

Wis., Kaukauna—Thilmary Pulp & Paper Co., awarded contract for construction of a 1 story, 135 x 200 ft. paper bag mill to Permanent Construction Co., 735 North Water St., Milwaukee, $40,000.

Mexico, Topolabampo—California-Texas Leasing Co., c/o J. F. Sadler, 81 South New Hampshire Ave., Los Angeles, Calif., and Presidio Petroleum Co., Presidio, Tex., H. W. Rowe, Midland, local rep., plan construction of an oil refinery plant here to include pipe line from Midland, Tex., to Topolobampo.